Human Factors
In Operations
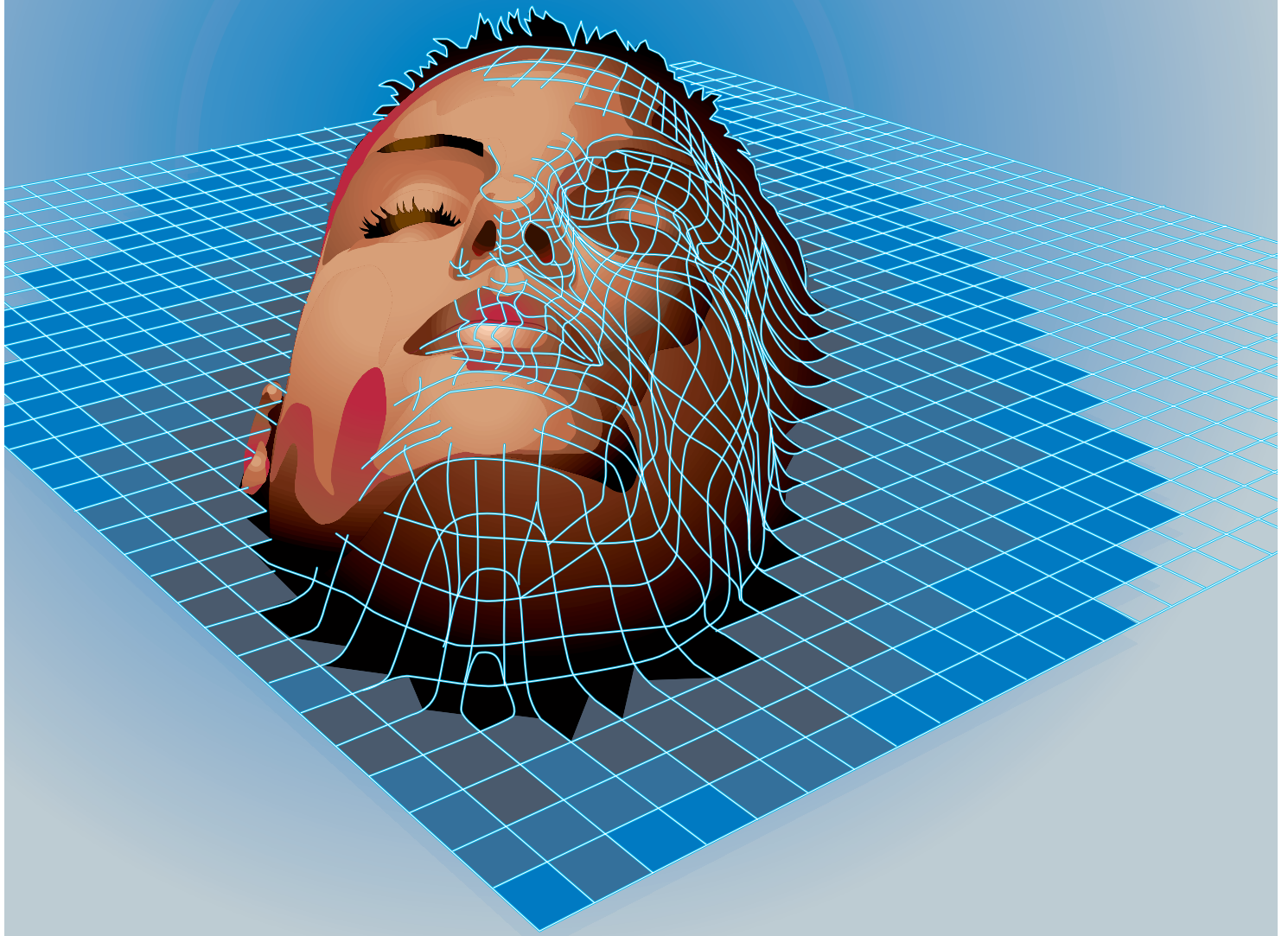
TEAM
AVLIS

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Team Resource Management Trainer's Manual

for the

Atomic Vapor Laser Isotope Separation Program

Tom Bennett

March 13, 1998

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The Two Most Important Impacts
of
Team Resource Management (TRM)

First: Predictable, Manageable Performance

A central premise of Team Resource Management (TRM) is that you can generally predict individual and team performance. This does not mean that we know exactly how well a team will perform. Nor does it mean that we know exactly how or when a team will fail.

TRM's central premise of prediction means that there are factors that can be used to predict performance extremely well. What is more important than our ability to use these factors to predict performance is that these factors can be **managed**. How the factors are managed determines the level of performance and the frequency of errors.

Just as TRM brings to **leaders** the concrete operational tools to better manage the factors that influence performance, TRM also brings to **workers** the concrete operational tools to better manage the performance-shaping factors of their team.

Second: Formalized, Structured Norms

TRM will bring about **observable** changes in the "dance" that teams perform as they conduct their technical tasks. Instead of seeing a team do a "two-step" shuffle that changes each time the team goes out on the floor, you will **recognize** them doing a tango when a tango is called for. The norms of the dance become formalized and reduce role and task ambiguity as they are practiced.

TRM is a tool with which to choreograph the best dance for a team. TRM allows a team to change the rhythm as the tempo of the music changes or even change the dance if the music changes. Because teams know and have practiced the "dance" that is called for, they do not step on each others' toes.

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Introduction to Team Resource Management

Goal

The goal of any operation is to complete tasks efficiently and effectively. Working safely is completely consistent with efficient, reliable operations. Working in an unsafe manner is not effective or ultimately efficient. If someone is hurt, work stops. Following the steps advocated by Team Resource Management (TRM) leads to more safe, efficient, effective work habits.

Process

TRM is a method used by teams (i.e., leaders and workers) to conduct technical business. This method is bounded by High Reliability Organizational Theory and based on Crew Resource Management (CRM) developed by the aviation industry. TRM is a more generic form of CRM and provides the glue that binds the technical activities of a team together.

High Reliability Organizations

A High Reliability Organization (HRO) is defined as one that conducts tens of thousands of high-consequence operations a year, essentially error-free. Naval air carriers, air traffic control, aviation maintenance, and commercial flight decks are examples of HROs.

The basic operating principles of HROs are steeped in the military combat tradition of distributed control. The success of a distributed control-based organization is dependent on the development of a shared-task model and clear definition of the roles and responsibilities of team leaders and members. Because distributed control-based organizations are often hierarchical, TRM can adjust to meet the demands of the task and the organizational groups the task encompasses.

TRM Process Flow

TRM is a meta-procedure that provides for a set of general activities to ensure the continued (a) validation of a shared task model, (b) maintenance of situational awareness, and (c) calibration and shaping of team leaders' and members' performance. Table 1 outlines the general TRM activities that various team members use to manage their technical activities.

1

Table 1. The main roles and responsibilities that different personnel have as team members. These TRM activities play a major role in managing the technical procedures of a team.

Personnel	Responsibilities
Team Leader	Assigning tasks, schedules, and resources (training, tools, parts, access, time, team composition, etc.).
Team Members	Completing tasks efficiently and effectively and notifying the Group Leader or Supervisor of resource limitations.
Worker	Doing the job as trained (following applicable procedures and work processes), communicating and collaborating with other team members, notifying Group Leader or Supervisor of personal limitations.

TRM Process Flow, cont.

Figure 1 depicts the process map of TRM. It clearly shows the controlling actions of the leader at the top and the monitoring activities of individuals toward the bottom. The middle section shows the team (leader and members) activities that are required to ensure the reliable and safe completion of any activity. The following sections describe the TRM process in more detail. For simplicity, all inter-relationships in the TRM process are not shown graphically.

The Players

The left-hand column in Figure 1 shows the list of characters that play essential roles in organizational reliability and safety.

Team Managers

The **Team Managers** have the responsibility of taking organizational requirements and setting them in motion. They determine what and when tasks have to be done, and they plan the task at a fairly high level. Team Managers establish the overall goals and performance criteria. They also ensure that the written culture of the organization (e.g., procedures and Facility Safety Procedures) are in place and that the unwritten norms (the implementation of the culture) reflect the goals of the organization and tasks.

Team Resource Management

NORMAL   **OFF-NORMAL**
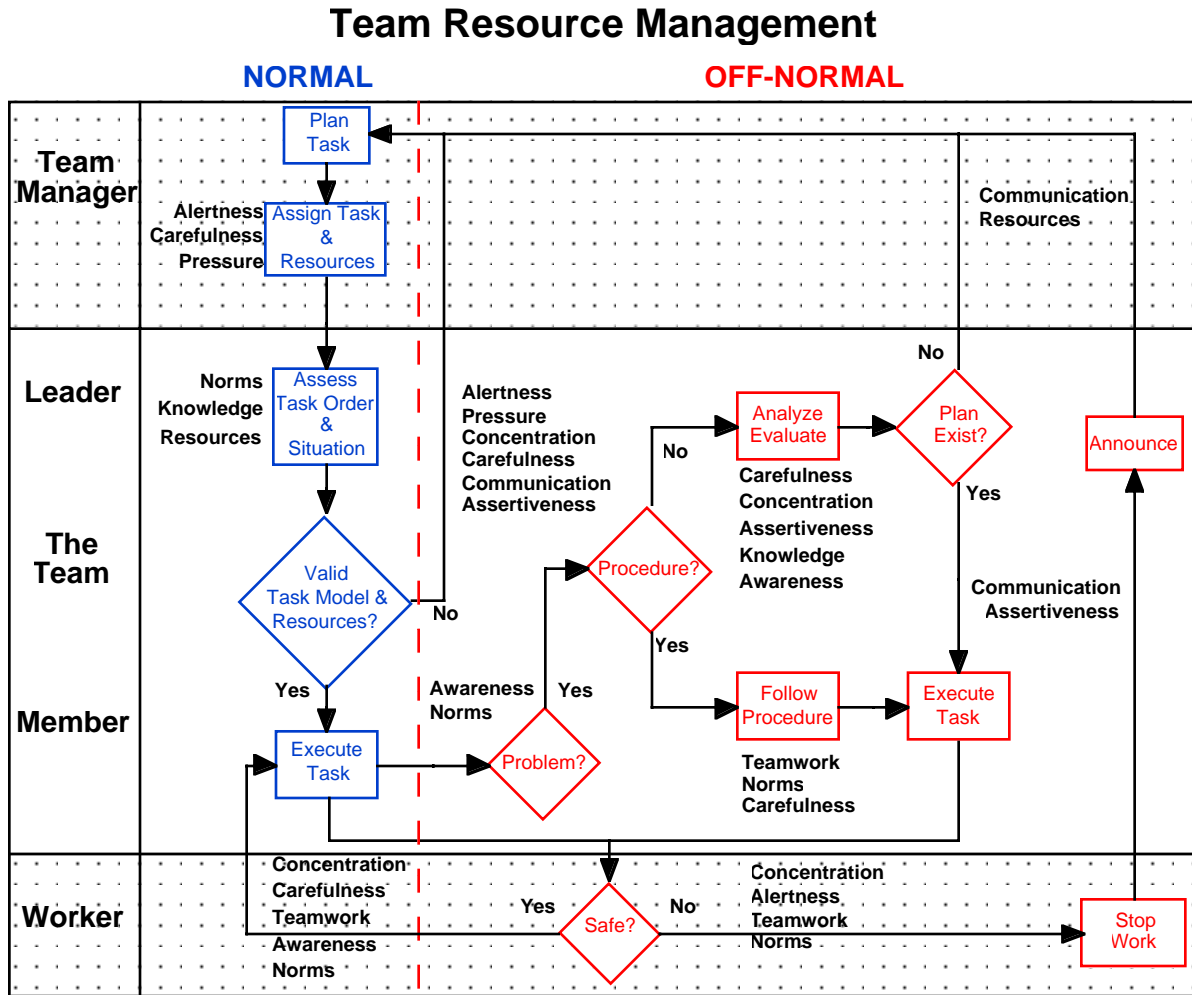
Figure 1. Team Resource Management Process Map. This is a meta-procedure used by teams to ensure the reliability and safety of their technical activities. For simplicity, not all process inter-relationships are shown.

Team Managers, cont. For example, the Separator/Technician Supervisor, Shift Supervisor, and Lead Operators are Team Managers who determine what major jobs have to be conducted and what schedule to use. The Team Managers use the Test Plan and other information from AVLIS Operations management. The Team Manager uses additional information from the teams to revise the task orders based on discussions with the team. In Figure 1, this is represented by the "no" loop from the Valid Task Model Decision Diamond. In the case of an off-normal condition, the Team Manager might determine that a new task plan is needed to be established based on information coming from the other feedback loops shown in Figure 1.

The Team

The **Team** is composed of the **Team Leader** and **Team Members**. Depending on the situation and task, the Team Manager may in fact be the Team Leader. In some cases, the team may be composed of nominally equal members with no specific leader providing direct supervision. In Figure 1, the Team Members are equivalent to the Worker listed along the bottom left-hand column.

The Team Leader is responsible for assigning and monitoring the physical and human resources needed for a task. The Team Leader is responsible for developing detailed plans on how the task is to be accomplished and making decisions regarding utilization of resources and schedule.

Team Members are required to:

- Keep the team's task and goals in mind.

- Continually appraise the situation in which the task is being conducted.

- Monitor the reliability and safety of the Team Leader and the other Team Members.

- Communicate changes in the situation and the status of their individual tasks.

The Workers

The **Workers** are called out separately in Figure 1 because, while we all work as a team to achieve our organizational goals, we are individually responsible for our own actions and ensuring that the team succeeds. We must remember....

If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as individuals....

As individuals, we must take all actions necessary to ensure that the team achieves its organizational goals. To do this, we must know (a) what the team goals are, (b) what the individual roles and responsibilities of the team members and leader are, and (c) what positive actions we must take to ensure the reliability and safety of our technical tasks. These positive actions are the central topic of the TRM workshop and are listed in Table 2.

The goal of the TRM workshop is to provide you with the tools to be a responsible and accountable member of the Atomic Vapor Laser Isotope Separation (AVLIS) team. The TRM activities are not only for workers in Building 490 who conduct the runs, but are also for all AVLIS personnel in the surrounding buildings who support the runs in one fashion or another, including design engineers, analysts, coordinators, secretaries, controls operators, and program managers.

Table 2. The characteristics teams need to balance as they monitor their technical activities. The negative column is Transport Canada's Dirty Dozen. The positive column is modeled after Kennedy Space Center's 12 Clues to Safety.

DIRTY DOZEN	THEIR POSITIVE DOZEN COUNTERPOINTS
Lack of Communication	Communication
Complacency	Carefulness
Lack of Knowledge	Knowledge and Task Experience
Distraction	Concentration
Lack of Teamwork	Teamwork
Fatigue	Physical and Mental Alertness
Lack of Resources	Necessary Resources
Pressure	"Time Out" to Pressure
Lack of Assertiveness	Necessary Assertiveness
Stress	Effective Stress Management
Lack of Awareness	Situational Awareness
Norms	Positive Group Norms

The Conditions   The TRM process map is also divided vertically into **Normal** and **Off-Normal** situations. The Normal column depicts the flow of activities and decisions that might occur during normal operations. The Off-Normal section of the map indicates the actions to be taken as a team or individual if a problem in task reliability or safety occurs.

Also shown in various places around Figure 1 are the positive actions (e.g., Alertness, Carefulness, Pressure) that the Team must take to ensure the reliability and safety of the team.

The Dirty Dozen   The **Dirty Dozen** constitutes the formal part of the workshop. The Dirty Dozen was developed by Transport Canada, the equivalent to the United States' Federal Aviation Administration (FAA). The Dirty Dozen was developed after a particularly thorough investigation of a plane crash in Ontario that killed all the crew and passengers. What the investigation concluded in no uncertain terms was that while the pilot took off when he should not have because of environmental and equipment conditions, he should not be held solely accountable for the accident. There were a set of serial and parallel processes set in motion by corporate and governmental policies, as well as individual actions of maintenance personnel, dispatchers, weather forecasters, and flight deck and cabin crew, that produced additional influences that contributed equally to the root causes of the accident. There were many people who should have been and were held accountable.

Background   The Dirty Dozen was developed to support a process called CRM. The U.S. aviation industry developed CRM with the support of the National Aeronautics and Space Administration (NASA) to improve the reliability and safety of flight deck operations.

CRM has become the benchmark for best business practices on commercial aircraft. It has also been adopted by commercial air maintenance operations, as well as the military and the launch crews at Kennedy Space Center. CRM is typically taught using a scenario-based approach that considers the **Task**, **Condition**, and **Standard** of a given activity. For example, the **Task** may be take-off. The

Condition could be engine-out. The **Standard** might be straight-in crash landing if below a certain altitude and air speed or return for landing if above those minimums. For this scenario, standards for pilot techniques and interactions have been developed. Pilots rehearse the script and are evaluated on their ability to interact as a crew. The training is conducted by specifically designated pilots and is extremely time and cost expensive. The aviation industry believes that because of the high consequence of flight operations, proper risk management justifies the expense.

Aviation maintenance operators have adopted a slightly different approach because of the numbers of personnel (tens of thousands) that are required to be trained. Transport Canada and United Air Lines developed a workshop based on the Human Factors Dirty Dozen. The training is still scenario-based, playing out real incidents that have occurred. However, it is done in a classroom setting with only part of the class playing out a given scenario at a time, with the rest of the class observing.

This approach, while significantly different in scope from CRM, has proved its success. A NASA-funded study conducted by the University of Southern California (USC) has shown the improvement in operational reliability and safety that occurred following initiation of this training.

Acknowledgments

Workshop Introduction and Human Factors 8:00–9:20

Summary of Unit 1 Schedule.

Section	Time Allotted 80 minutes
1.1 Get Acquainted and Schedule	10 minutes —1 VG
1.2 Objectives and Goals	5 minutes —3 VGs
1.3 Human Factors and Team Resource Management	20 minutes —2 VGs, 3 minute video ("Blaming the Pilot," 1:27.52–1:30.35, New to TRM)
1.4 Organizational and Employee Challenges	10 minutes —3 VGs
1.5 Approaches to Human Error	35 minutes —4 VGs, 14 minute video ("60 Minutes, F-15")

1.1. *Get Acquainted and Schedule*

1.1.1. Time Schedule and Materials	8:00 — 10 minutes. 1 VG, Survey handed out to assess preconceptions of TRM, reliability, and safety.
1.1.2. Subject	Provide administrative basics.
1.1.3. Objectives	Describe the associated paper work, classroom, and facilities. Take survey on attitudes and beliefs about crew and individual performance.
1.1.4. Methods to be Used	Lecture and classroom discussion.
1.1.5. Content	Present basic safety information (exits, where to assemble, fire extinguishers) as well as location of rest rooms.
Times	The following is a schedule of the workshop:
8:00-9:20	Workshop introduction and discussion of aviation human factors training and approaches to human error.
9:30-10:20	Predicting individual and team performance, culture/norms/values/attitudes, and professionalism.
10:30-11:45	Dirty Dozen: #1-Communication, #2-Carefulness, #3-Knowledge, #4-Concentration, #6-Alertness.
13:00-13:50	#7-Resources, #8-Pressure, #9-Assertiveness, #10-Stress.
14:00-14:50	#11-Awareness, #12-Norms, #5-Teamwork, Operational Risk Management.
15:00-15:50	Exercise and workshop summary.
1.1.6. Learning Criteria	Students answer most questions asked by instructor.

1.2. *Course Objectives and Outline*

1.2.1. Time Schedule and Materials	8:10 — 5 minutes.
	Title & VG1—Hello
	VG2&3 Goals
1.2.2. Subject	Describe workshop outline and objectives.
1.2.3. Objectives	Ensure that students have a basic understanding of the course structure and the purpose of the workshop.
1.2.4. Methods to be Used	Lecture and classroom discussion.
1.2.5. Content	Team Resource Management's motto: "***If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as an individual***."
Introduction, Background, and Goals	High reliability organizations do exist. They have been defined as those organizations that conduct thousands of high-consequence operations a year, essentially error-free. Naval air carriers, air traffic control, and commercial aviation are some of these kinds of organizations.
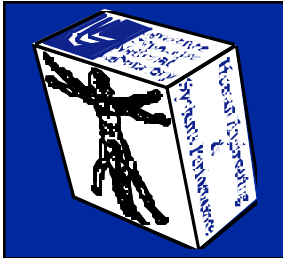
High Reliability Teams

How did they get that way? What kinds of people staff them? Can we become a high reliability organization?

This workshop will look at these questions. When we are done, it will be up to you to determine whether we have the right stuff.

Workshop Goals   There are six goals for this workshop.

Human Factors & Teams

Goals of the
Team Resource Management (TRM) Workshop

- **Goal I: Describe Team Resource Management and its purpose**
  – **High-level process to manage technical work**
  – **Improve team reliability and safety**

- **Goal 2: Describe Performance Shaping Factors (PSFs) and their role in predicting and managing team performance and errors**
  – **Internal and external PSFs**
  – **Root Cause analysis and accountability**

- **Goal 3: Describe the principles for managing human error**
  – **Reactive and proactive approaches**
  – **Process management and procedures hazards analysis**

Bennett, 1/30/98, ##   Our Goal for Today is to Have Zero Human Errors

Goal 1:   TRM is a process that helps teams manage the conduct of their technical procedure in an orderly, systematic fashion. TRM supports the process management of tasks and operational risk assessment to enhance team reliability and safety. TRM (a) defines the roles and responsibilities of teams, (b) helps develop and maintain a shared concept of the task and its status, and (c) provides tools that act as safety nets to optimize team performance in the face of conditions that might promote human error.

Goal 2:   Individual and team behavior can be generally predicted (specific internal and external factors increase the likelihood that we will act in a certain way). The factors that influence individual and team behavior are called Performance Shaping Factors (PSFs), which can be used to predict behavior and, in turn, can be managed to influence behavior. Because PSFs influence behavior, they should be the central focus of a root cause analysis. The person or team that was the immediate cause of an incident should not be solely held accountable. The people responsible for managing the PSFs should also be held accountable.

Goal 3:   Just as individual and team behavior can be generally predicted, so too can human error. Reactive methods are necessary because we do not have the time or resources to reliably predict human performance to the degree we would wish. Reactive methods include root cause analysis and lessons-learned databases. Proactive methods use risk management tools to understand the failure modes of an operation. Using various psychological principles, methods are systematically developed to optimize human and team performance and mitigate against errors.

Human Factors & Teams

**Goals of the
Team Resource Management Workshop**

- **Goal 4: Describe TRM's 12 rules-of-thumb (the "Dirty Dozen") and use of safety nets**
    - **Assume trained people will commit errors and act as part of a team to eliminate errors**
    - **Individual (technical) training and team (process) management training go hand in hand**
- **Goal 5: Conduct Operational Risk Management (ORM)**
    - **Rapid, systematic assessment of situation and task**
    - **"Good-enough" management of risk**
- **Goal 6: Demonstrate ways to keep TRM working**
    - **Measure the processes that TRM is supposed to manage**
    - **Monthly process management meetings, principled shift change meetings, and ORM briefs**

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors

Goal 4:   The "Dirty Dozen" came from Transport Canada and was developed from actual incidents in aviation. Kennedy Space Center believes (as do we) that the dirty dozen can be turned into rules-of-thumb (heuristics or learning aids) that teams can use to optimize their performance. People can be well qualified individually, but fail as part of a team. Team performance is dependent on clearly defined roles and responsibilities and a shared model of the task. We know that task reliability is dependent on more than technically qualified people. Teams, by themselves, do not ensure reliability. Teams must be taught how to manage their processes.

Goal 5:   Operational Risk Management (ORM) is a tool that the military uses to understand the hazards to the success of a mission. ORM provides a systematic, rapid process for assessing the risk of a mission by evaluating (a) the task (What are they supposed to do?), (b) the conditions (What

are the environmental factors?), and (c) the standards (How will they know they have succeeded?). ORM provides principles for understanding at what level a task risk assessment should be done and to what level of detail the analysis should be conducted. ORM can be conducted as part of the shift change meetings or pre-job briefs. ORM is used to further clarify roles and responsibilities for a specific job, as well as ensure the existence of a shared task model among all the team members.

Goal 6:   TRM improves team reliability and safety. Set high-level, long-term (6 month) and "in-the-trench," short-term (daily and weekly) goals for your work products and safety. Measure them. "What have I produced for the company? How efficiently have I done it? How safely have I done it? Have I followed rules? Have I made my job better?" We are asking and answering these kinds of questions of everyone in our shift change meetings. Process management addresses monitoring and improving the job. Many of our groups have weekly meetings to review how we're managing our tasks.

Shift change meetings focus on the daily work. Process management focuses on better ways of doing our tasks. And, ORM focuses on reliability and safety of specific jobs. In a sense, activities like shift change meetings, process management, and ORM provide the framework for TRM.

1.2.6. Learning Criteria   Informational only.

1.3. *Background on Aviation Human Factors Training*

1.3.1.	**Time Schedule and Materials**	8:15—20 minutes.

VG4—Human factors engineering

VG5—Systems engineering and modeling

Video—"Blaming the Pilot," 3 minutes, 1:27.52–1:30.35 |
1.3.2.	**Subject**	Explain human factors and the use of systems engineering.
1.3.3.	**Objectives**	Provide basic definition of human factors and how systems engineering is used by psychologists to study organizations.
1.3.4.	**Methods to be Used**	Lecture and classroom discussion.
1.3.5.	**Content**	Human factors involves the study of how people interact with physical systems. The physical system could be an electronic game or a nuclear weapon. What is often forgotten is that the human is only one half the system—the other half is the physical system. When human factors scientists speak of systems, they speak of the total human-machine system. It is the human-machine system that produces the product of "the system."
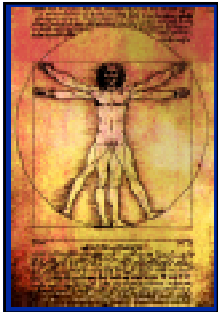
Human Factors Engineering

Human Factors & Teams

- Engineering is the art and science of making matter & energy more useful to man

- Human Factors Engineering is the art & science of making systems more useful to man

"The Rule of Proportions," Da Vinci in *Leonardo* by Bacci, 1978.

Human factors engineers are typically trained in psychology as well as other technical disciplines, ranging from computer science to engineering to aviation.

This workshop will be about a specialized part of human factors, a part that helps organizations become more reliable and safe by managing their processes and ensuring that their people work as a team to improve the robustness of the organization. The premise is that if individuals work cohesively as a team to get tasks done instead of working as individuals, the organization will be more reliable and safe.

However, organizations have to make sure that their processes are as efficient as possible and meet the capabilities of their people. This is where systems engineering and human factors link up. The basic premise is that an organization can be modeled as a system, with each of its organizational elements being subsystems that contribute to achieving the organization's mission and goals.

Problem Solving Flowsheet
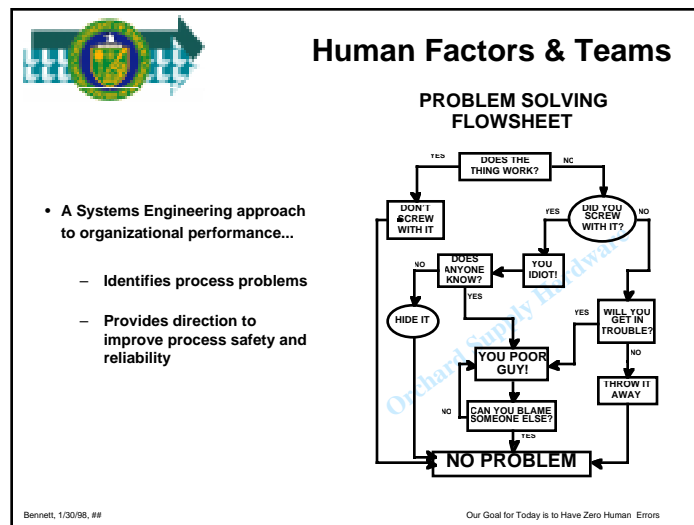
"Systems engineering" is different than "engineering a system." Unfortunately, the latter is more prevalent and means that an engineer got a bunch of parts to work together, regardless of whether anybody can use the system.

One of the important values of systems engineering is that it can take a complex system and decompose it into components that are more easily understood.

Some systems engineers look at equipment, while others look at organizations, which can be viewed as systems also. Each of an organization's functions (production, human

resources, training, sales) is a subprocess, like a starter for a motor or a graphics engine in a computer.

Systems engineering looks at the requirements of the system, then designs it to meet the customer's needs. Systems engineers use a variety of tools to understand the system they are designing. Some of the most powerful include the graphical representation of a system—a model.

Here is a tongue-in-cheek example of a graphical model of an activity. It was found on an employee bulletin board at Orchard Supply Hardware (OSH). It's not meant to indicate how OSH does business! It's merely a way employees were having fun looking at themselves.

A graphical model of a team activity is essential for completeness as well as for providing the basis for poking fun at how you do business. It helps ensure that there is a "shared model" of an organization.

Research has shown that failure to develop and maintain a "shared model" is one of the most significant causes of failed missions. A shared model provides all team members with a common notion of what the task is:

- What are the threats to getting the task done?

- Who is supposed to do what…when?

- What is the status of the system and task?

A shared model is the underpinning for distributed control. You can globally constrain, yet locally determine tasks. And, systems engineering tools, like process management, can help us map out our activities.

1.3.6. Learning Criteria   Students answer most questions posed by instructor.

1.4. *Organizational Problems are Your Problems...There Is a Solution*

1.4.1.	**Time Schedule and Materials**	8:35—10 minutes.
		VG6&7—What you have signed up for here?
		VG8—TRM as a meta procedure.
1.4.2.	**Subject**	Explain the responsibilities of the employees to the organization for which they have agreed to work. Explain that TRM is a high-level process that is used by groups to manage their technical procedures.
1.4.3.	**Objectives**	Be able to explain employees' responsibilities to ensure the company is successful and tell how TRM helps teams achieve organizational goals.
1.4.4.	**Methods to be Used**	Lecture and classroom discussion.
1.4.5.	**Content**	Many people hire into the Lab because of its good pay and job security. The basic motivation to work here, or any other place, should be because the organization will allow you to become the best at whatever your profession is — from technician to physicist. Pay and benefits should be just icing on the cake.
		That said, it is important to face facts. You have hired into an imperfect Lab. Its processes are flawed. You work with some individuals who have suboptimal motivation. (We hope you didn't look at anyone in particular at this point!) Despite this, it is your responsibility, as long as you work for the Lab, to make the Lab succeed. You will be held accountable if the Lab (or your piece of it) fails.
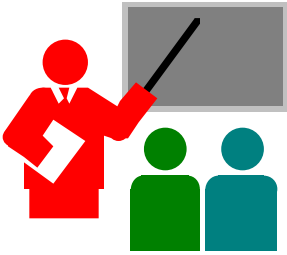
Did you know?

Human Factors & Teams

Did you know?

- We do not have a perfect organization!
  - Planning
  - Resources
  - Training....
- But....you are expected to be accountable and succeed!

What do you know?   If you don't like it, you can try to fix it; or, you can leave.
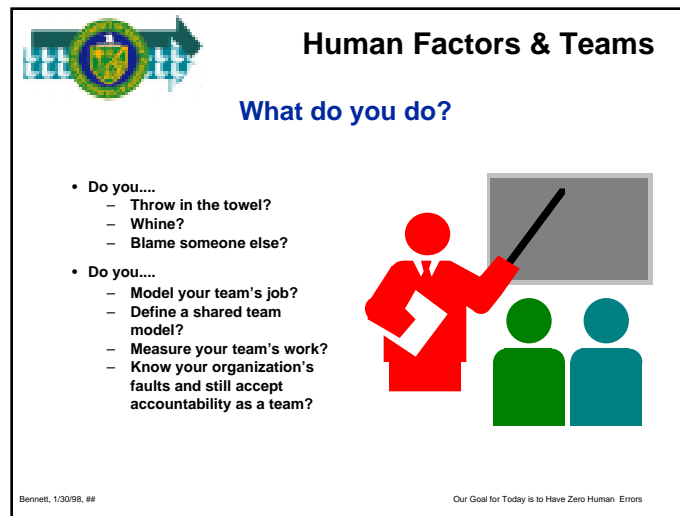
If you elect to stay, there are solutions—but, they take work. If you want to become one of the High Reliability Organizations mentioned, there are principled approaches—TRM—to at least minimizing the problems.

In aviation, the airway to high reliability and safety was through CRM, a willingness to accept accountability, and an acknowledgment by management that individuals should not be held solely accountable for what are latent organizational errors.

TRM as a meta process
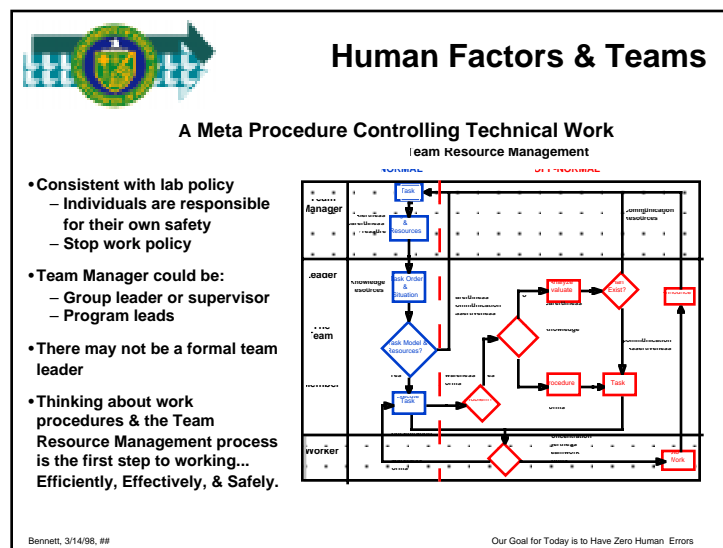
Here is another example of a system process that will be discussed during the workshop. The concept is that there

are two ongoing sets of operations that a good team manages simultaneously.

The principal operation of a team is the technical one that turns out its product. The other operation is one that should be running in the background all the time—it is a meta, or high-level, process...TRM...that ensures that the technical operation is being conducted properly.

In the past, it was assumed that once a team started its technical operation, the team would just naturally know how to (a) organize itself, (b) ensure that each team member was doing the right job at the right time, and (c) check to see if it was doing the job reliably and safely.

Was this ever wrong! In aviation, it took several decades, thousands of lives, and billions of dollars before they discovered how the technical work of teams can break down, even if the team members are the most qualified in the world.

The Players   The left-hand column in Figure 1 (see page 3) shows the list of characters that play essential roles in organizational reliability and safety.

Team Managers   The **Team Managers** have the responsibility of taking organizational requirements and setting them in motion. They determine what and when tasks have to be done, and they plan the task at a fairly high level. Team Managers establish the overall goals and performance criteria. They also ensure that the written culture of the organization (e.g., procedures and Facility Safety Procedures) is in place and that the unwritten norms (the implementation of the culture) reflect the goals of the organization and task.

For example, the Separator Tech Supervisor, Shift Supervisor, and Lead Operators are Team Managers who determine what major jobs have to be conducted and what schedule to use. The Team Managers use the Test Plan and other information from AVLIS Operations management. The Team Manager uses additional information from the teams to revise the task orders based on discussions with the team. In the viewgraph, this is represented by the "no" loop from the Valid Task Model Decision Diamond. In the case of an off-normal condition, the Team Manager might

determine that a new task plan needs to be established based on information coming from the other feedback.

Most importantly, the task leader must clearly define the roles and responsibilities. Tasks must be laid out explicitly. Team members do not want ambiguous work instructions, or they may take the path of least resistance and not perform the task the leader had intended.

For example, instead of saying to team members, "We'll continue the pod build today," the team leader should explicitly specify the necessary tasks to be completed for "continuing the pod build" and list them on a task list board. Team members would then check the tasks off as the activities are completed. This is another example of a positive team norm.

The Team

The **Team** is composed of the **Team Leader** and **Team Members**. Depending on the situation and task, the Team Manager may in fact be the Team Leader. In some cases, the team may be composed of nominally equal members with no specific leader providing direct supervision. Team Members are equivalent to the Worker listed along the bottom left-hand column in Figure 1.

The Team Leader is responsible for assigning and monitoring the physical and human resources needed for a task. The Team Leader is responsible for developing detailed plans on how the task is to be accomplished and making decisions regarding utilization of resources and schedule.

Team Members are required to

- Keep the team's task and goals in mind.

- Continually appraise the situation in which the task is being conducted.

- Monitor the reliability and safety of the Team Leader and the other Team Members.

- Communicate changes in the situation and the status of their individual tasks.

The Workers

The **Workers** are called out separately because, while we all work as a team to achieve our organizational goals, we are individually responsible for our own actions and ensuring that the team succeeds. We must remember....

If we fail as an individual, we fail as a team. If we succeed as a team, we succeed as individuals.

As individuals, we must take all actions necessary to ensure that the team achieves its organizational goals. To do this, we must know (a) what the team goals are, (b) what the individual roles and responsibilities of the team members and leader are, and (c) what positive actions we must take to ensure the reliability and safety of our technical tasks. These positive actions are the central topic of the TRM workshop.

The goal of the TRM workshop is to provide you with the tools to be a responsible and accountable member of the AVLIS team. The TRM activities are not only for workers in Building 490 who conduct the runs, but are also for all AVLIS personnel in the surrounding buildings who support the runs in one fashion or another, including design engineers, analysts, coordinators, secretaries, controls operators, and program managers.

The Conditions

The TRM process map is also divided vertically into **Normal** and **Off**-**Normal** situations. The Normal column depicts the flow of activities and decisions that might occur during normal operations. The Off-Normal section of the map indicates the actions to be taken as a team or individual if a problem in task reliability or safety occurs.

Also shown in various places around the process map are the positive actions (e.g., Alertness, Carefulness, Pressure) that the Team must take to ensure the reliability and safety of the team. These are the Human Factors Dirty Dozen.

1.4.6. Learning Criteria

Class answers most questions posed by instructor.

1.5. *Human Error and Accountability*

1.5.1.	**Time Schedule and Materials**	8:45—35 minutes

                                   VG9—Error iceberg

                                   VG10—Proactive and reactive approaches to HE reductions

                                   VG11—Chain of events

                                   VG12—Common notions vs. theory

                                   Video—"CBS 60 Minutes, F-15," 14 minutes

1.5.2. Subject

Basic approaches to human error management; the Lab's and other common approaches to human error analysis and mitigation; and the role of culture, norms, values, and attitudes in the reliability and safety of individual and team performance.

1.5.3. Objectives

Discuss current approaches to human error and compare them to how the Lab approaches safety and reliability.

1.5.4. Methods to be Used

Lecture and classroom discussion.

1.5.5. Content

No one sets out to make an error. We do not wake up in the morning and say, "Today is going to be the big one! I'm really going to screw it up."

We know that in many high-consequence industries (e.g., aviation, nuclear research), approximately 90% of the accidents are caused by human error. That is, the engineering designs and controls have become so good that few accidents are the result of mechanical failure.

Error Iceberg
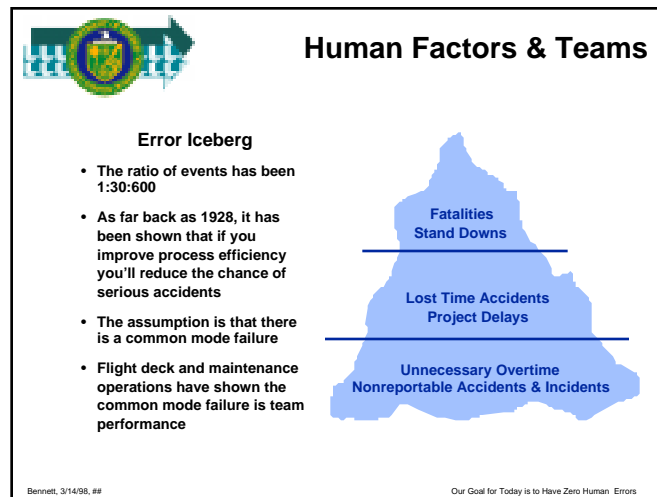
These are the error iceberg statistics for aviation. Most people believe that if you work on reducing the lowest level of human errors (the ones that lead to minor injuries, overtime, missed schedules), you will ultimately reduce the frequency of the most serious accidents.

The notion that if you shrink the base of the iceberg, you will shrink the whole iceberg, is based on the assumption that there is some common mode failure present in an organization. That is, if you eliminate the failure mode (or, at least decrease the probability of it occurring), you will reduce all accidents.

In the aviation industry, there is strong evidence from accident statistics that the common mode failure is team performance. By improving crew performance, reliability and safety of the system significantly improve.

Much of this work is bounded by High Reliability Organization (HRO) Theory developed over the last decade or so. The theory has characterized HROs as those that are based on distributed control with clearly defined roles and responsibilities of the teams.

CRM is based on the military approach to training that is organized on the basis of tasks, conditions, and standards. It is scenario-based training. TRM is an adaptation to meet schedule and resource demands. The worth of TRM has been proven by NASA and USC studies that have shown significant decreases in maintenance errors (33%) and lost-time accidents (21%).

Approaches to Error Mitigation
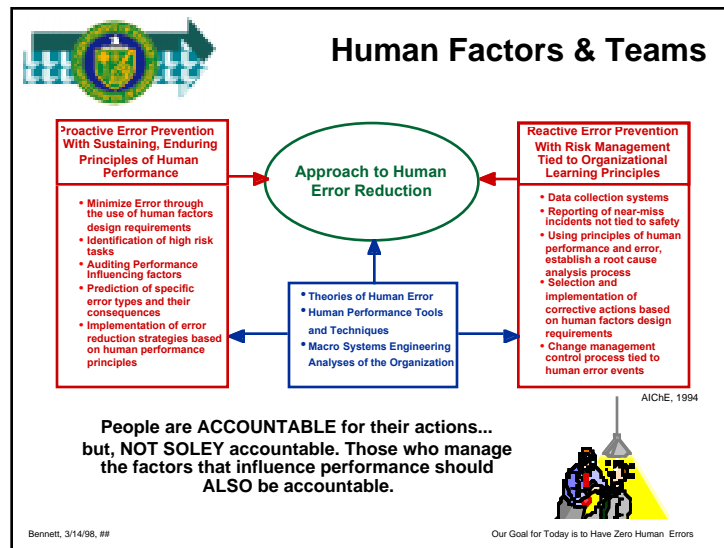
In the past the Lab has focused on the reactive approach to error mitigation. It is now moving towards a more balanced proactive approach. Integrated Safety Management System is one example.

There are many factors that influence team performance. The team members are only one consideration. The people who manage the factors (resources, scheduling, training) that shape performance should also be accountable.

Both proactive and reactive approaches to mitigating human error are required because we cannot precisely predict human behavior. Proactive actions prepare the system and people to be more robust. Reactive approaches provide mitigation for those unanticipated and unpredictable errors.

IF YOU DON'T HAVE A PROACTIVE PROCESS.... YOU'LL ALWAYS BE REACTIVE....DEALING OUT BAND-AIDS.

When an error occurs in a team setting, the probability of a human error being traced only to a single individual is virtually zero. All too often, and mistakenly, it is thought that the engineering model of using root cause analysis for human failures implies that there is a single point failure, a single individual, who is at fault. In a team activity, there are always many contributing factors—equipment design, team cross checking, team communication, team self correction, team management, the team's internal PSFs, as

well as organizational schedule, resources, and the team's external PSFs that determine behavior.

Human and team behavior are shaped by internal and external PSFs. These are the contributing factors.

If the external shaping factors are "nominal," then the team is accountable. If the internal shaping factors are "nominal," then, and only then, may a single individual be accountable. An incident investigation team is obligated to explore the external and internal team PSFs before they even consider holding a single individual accountable.

For every error or problem, there is almost always someone who had the opportunity to catch it!

Chain of Events
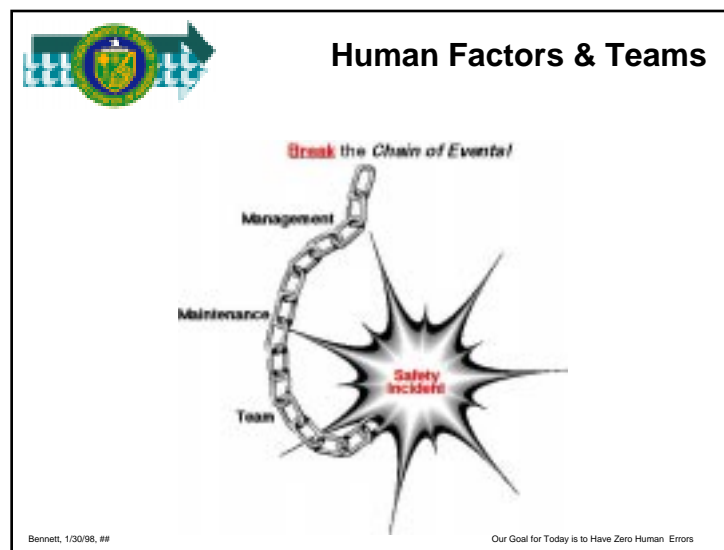
We know now that accidents are the result of a chain of events (contributing factors), that, if broken, would have prevented it.

Titanic

Look at the sinking of the Titanic. What caused it to sink? An iceberg? What about design decisions that allowed high-sodium-content steel (brittle when cold) to be used in the North Atlantic? What about the company's arrogance (this ship is unsinkable) that allowed the ship to run full speed through an ice field for promotional reasons?

Operational error is not the cause of an accident. The cause is to be found in those performance shaping factors (management, organization, personal) that lead to the error.

A human error is just the final link in a chain of events that ended in an accident. Any one of the people involved in the events leading to the accident should be held as accountable as the person whose act finally produced the accident.

Three Mile Island   As the investigators of Three Mile Island (TMI) said....

> "Some previous analyses have attributed it (the cause) to human error. *We reject that hypothesis....*
>
> There were factors not within the operators' control—poor procedures, inadequate training, and lack of management."
>
> > Rogovin and Frampton, from *The President's Commission on The Accident at TMI, 1980.*

Common and Scientific Notions about Human Error

Human Factors & Teams

Popular Notions About Human Error

- Human error is inevitable
- Little can be done to prevent human error
- Assumed causes
  - Carelessness
  - Poor Attitude
  - Inattention
- Assumed cures
  - More Training
  - Admonition
  - Punishment
  - Discharge

Scientific Position on Human Error

- Man is a reliable system under certain defined conditions
  - Individual performance can be predicted
  - Team performance can be predicted
- Human error increases with system complexity and ambiguity
- Many causes of human error are in external systems
  - Physical Systems
  - Social Systems
  - CAN BE MANAGED

Adapted from Kennedy Space Center's HF Team

Bennett, 3/14/98, ##   Our Goal for Today is to Have Zero Human Errors

In the viewgraph, we compare commonly held notions about human error. On the left is the usual "**Blame and Train**" mentality. Figure out who did it, punish them, and retrain.

People do not spend time looking at the factors that increased the likelihood that someone would commit an error, then fix those problems.

Just because you "blame and train" does not mean you will change the probability of an accident, unless you address the root causes.

1.5.6. Learning Criteria   Students answer most questions posed by instructor.

2. Predicting Individual and Team Performance and Norms and Culture 9:30–10:20

Summary of Unit 2 Schedule.

Section	Time Allotted 50 minutes
2.1 The Lab and Teams	15 minutes —6 VGs
2.2 Predicting Performance	10 minutes —2 VGs
2.3 Culture and Norms	20 minutes —6 VGs, 6 minute video ("Crash Detectives," 1:26.25–1:32.45, Cargo Door)
2.4 Professionalism	5 minutes —2 VGs

2.1. The Lab, Individuals, and Teams

**2.1.1 Time Schedule   9:30—15 minutes
        and Materials**

> **VG13—A new approach to HE**
>
> **VG14—Venting incident**
>
> **VG15—Aviation and the fatal assumption of crew reliability**
>
> **VG16—HE in nuclear operations**
>
> **VG17—HE, TMI, and root causes**
>
> **VG18—We must stop and see why we keep making the same types of HE**

2.1.2 Subject   Individuals should be accountable for their actions. But, so should those who control the factors that lead people to act one way or another. We cannot assume that teams provide more robust (safe and reliable) performance. They must be trained to act as a team. Human Error (HE) is the last link in the chain of events leading to an incident.

2.1.3 Objectives   Describe contemporary views of human error mitigation and what can be done at the Lab to improve operational reliability and safety.

**2.1.4 Methods to be   Lecture and classroom discussion.
        Used**

2.1.5 Content   How does the Lab do business? In the past, we hired qualified people, told them to go work safely, and when they did not, we would punish them and require that they receive remedial training.

**The Lab's Future
Position on Error
Mitigation**

What we should be doing is (a) formalizing our work processes (as opposed to just assuming that people know what is expected), (b) training people to look at their work as a process that can be managed, (c) training people how to work on teams, (d) and realizing that good people make mistakes because of influences that are out of their control.

Latent organizational errors that influence human and team performance include inadequate organizational control that promote at-risk performance. In the past, we have looked at safety as something that needed to be addressed separately from our processes. A lot of time is spent looking at the hazards in a room, without looking at how the work that is done in the room can fail.

A perfectly designed system is efficient (from an economic perspective) and reliable. A perfectly designed system does not have accidents because it is inherently safe.
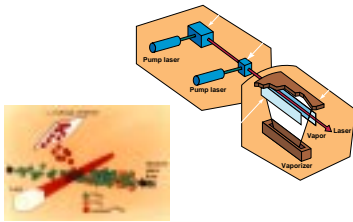
Let's look at an incident in AVLIS to get a better idea of what Team Resource Management is all about.

Venting Incident in AVLIS

On the surface, this was a classic example of poor communication—end of story. In reality, it was identical to the problems in crew coordination that had been studied at NASA Ames, including the response of management.

Just as with pilots, the lead technician blamed himself. Other lead technicians blamed him. He screwed up and was held solely accountable.

But, it was a team operation, anyone could have stopped the operation. They just weren't tuned in to the ambiguous communication. They weren't on guard against any mishap. They were complacent.

Management had not thought it important to provide the training in Team Resource Management. Management thought the people should have known better. In hindsight, at least, it was all too obvious they did not know better.

On the flight deck and in maintenance aviation, it was found that team behavior is something that has to be taught and practiced. Organizations must spend time managing the processes and also training workers and lead technicians to work as a team, not as separate individuals working independently.

**The Beginning
of TRM**

Aviation thought that because there was a crew, the process was more reliable and safe. A study of Controlled Flight Into Terrain (CFIT) accidents—during instrument approaches over a 20-year period—showed that the accident rate was the same whether a crew was flying the aircraft or a single pilot was. (CFIT is an accident flown into the ground with the crew in full control of the aircraft. They did not realize that they didn't know where they were.) If one pilot was drawn into a problem, both were. Aviation was expecting something from people in a team situation that they had never taught them. Aviation learned that TRM is not something you necessarily pick up on your own. But, the data show that you can learn TRM.

Commercial aviation thought it was buying robustness when it was hiring military pilots. The problem that no one realized was that the military was never training crews to work as a team. This was a fatal flaw that no one noticed. And, now, the biggest endorsement to TRM is that military aviation has adopted the process.

TRM is a process steeped in military ground operations. It is based on distributed control and a shared model of what the job is about. TRM clearly defines the roles and responsibilities of the team. They train as individuals to perfect their individual skills. They then train as a unit to perfect their team skills. Military aviation came from a different tradition.

Military aviation is adopting another tradition from the army (one that has some history in commercial aviation in the form of Aeronautical Decision Making). It is called Operation Risk Management; we will talk about it at the end of the workshop.

There is another important side bar to how aviation views reliability and safety. In aviation operations, the term safety encompasses both safety and process reliability. Here is a good example:

To improve civil aviation safety, the FAA asked NASA Ames Research Center to establish the Aviation Safety Reporting System (ASRS). Now, over 25 years later, there are more than 350,000 reports in that database.

Not one of those 350,000 are about a fatality, nor someone getting injured, nor the loss of an aircraft. They're about altitude busts, runway incursions, speed deviations, and navigation errors.

The database was designed to understand the little events that might come together to lead to an accident.

It is important to understand HOW aviation THINKS ABOUT safety, and WHY the word SAFETY is in ASRS's title, when the database contains no accident reports.

In aviation the words "safety" and "reliability" are fused together in everyone's mind whether he or she is a pilot, a flight attendant, a mechanic, or someone who works in the tool crib.

**Nuclear Research
Safety**

Human Factors & Teams

Safety in Nuclear Handling?

- There have been 42
  criticality incidents...
  – **10 with the loss of life**
- Of the 42 criticality
  incidents...
  – **38 involved human
    error**
- Almost all have involved
  research activities...

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What these data do not say is that the rate of such incidents
has been flat in the United States for many years.

Many of the reports of these accidents are not written in a
way that we could look at organizational errors. We will
simply assume that people involved in these accidents were
not working in isolation from a larger system that
influenced how they managed their work activities.

Over the decades, AVLIS Operations have been safe. But,
even one fatality is too much. And, of course, a regulator
thinks one violation is too much. We have to recognize
that we are working in the Age of Compliance.

There are multiple demands that we must meet.
Fortunately, the pendulum is swinging back to a more
reasoned approach towards integrating processes and rules.
TRM is one way we can influence what is being called
Integrated Safety Management System.

**Three Mile Island's
Control Room**

An accident chain is a series of events that ultimately lead to an accident. Looking at an accident chain post hoc always gives the impression that you could predict that the accident was going to happen. This is not always the case, as we shall see. The main reason for looking at an accident chain is to see if the influencing factors are still present.

The phrase "source term" refers to root cause. In any case, root cause analysis was never intended to be used to find the last event (who pushed the button) in an accident chain, but to find where the accident chain started. The accident chain's roots may have multiple sources.

With regard to Three Mile Island (TMI), people have tended to forget that the utility rushed the plant into service almost three months early to avoid a $240M tax. It cost them tens of billions of dollars.

One of the main points is that the control room operators were viewed in isolation from the rest of the plant. It was assumed that the extended team (procedures, training, management) would have taken care of business. We know that the TMI team failed. They failed as individuals. They failed as a team.

One of our lead operators sent us this quote when the workshop was being prepared. Its message is important.

Take the Time
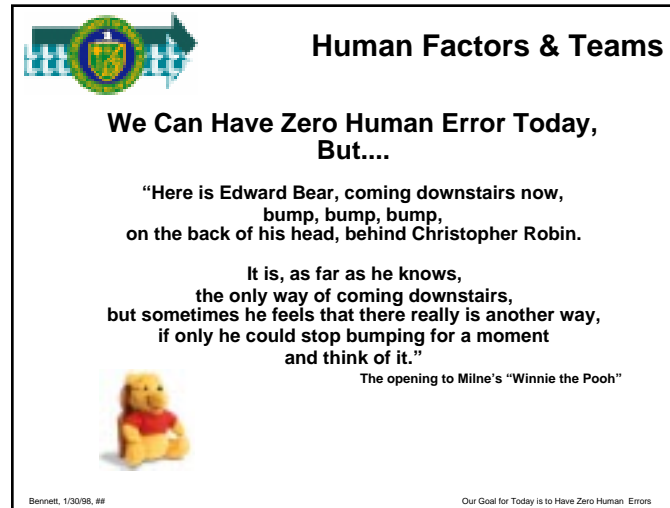
"And, here we are, things keep bumping down the organizational ladder, no one ever taking time to look for a better way."

We know what it means to set a day aside to take this workshop, especially during our busy schedules. We have been safe. Our record is good. But, our incidents have not been going away. We need to find a better way of handling them.

As we'll see, High Reliability Organizations have taken the time. Team Resource Management and Operational Risk Management are ways High Reliability Organizations have become just that.

Humans will err, even in High Reliability Organizations. Errors can be tolerated. The difference in a High Reliability Organization is that the errors that lead to catastrophic accidents are the errors that are controlled by taking advantage of the robustness a team can bring (and, not just assuming that the team will do it reliably and safely). It is not done by avoiding errors. It is done by trying to manage processes as perfectly as possible (within acceptable risk).

2.1.6 Learning Criteria   Adequately answer questions posed by instructor.

2.2   Can You Predict Human and Team Performance?

2.2.1	**Time Schedule and Materials**	9:45—10 minutes

VG19—Individual performance predictions and PSFs

VG20—Team performance predictions and PSFs

2.2.2	**Subject**	Human behavior can generally be predicted. There are factors we can use to predict and manage (direct) human behavior. The same principle applies to team performance.
2.2.3	**Objectives**	Describe what Performance Shaping Factors (PSFs) are and how they can be used to manage human performance.
2.2.4	**Methods to be Used**	Lecture and classroom discussion.
2.2.5	**Content**	We know exactly the probability of winning the lottery (1.4×10^{-7}). How well can we predict if we are going to win the lottery today? Not very reliably... 1.4×10^{-7}...not too good.

Predicting Human Performance

How well can we predict whether you are going to come into work tomorrow? If I check your schedule for tomorrow, we would probably be able to make a pretty good prediction. We can make these predictions about people a lot more reliably than about the lottery because the factors that influence the lottery are purely random.

Much of human behavior can generally be predicted. The accuracy of predicting whether you are going to be coming

into work tomorrow is going to be less than perfect. Much of your behavior is influenced by factors around you, but you do have free will, and there are random factors. Free will—you can take this job and shove it. Random factors—things like getting in a car accident or tripping on your untied shoe laces.

We are all pretty good at predicting somebody's performance. If we weren't, it would mean that either we are crazy, or the other person is crazy. How come we can be so good (at least a lot better than the lottery)? We know that pay influences someone's reliability. We know that past history can be used to predict future performance. We have some sense of how family problems influence reliability and also drugs and alcohol. We know that values ("It's important to come into work today") influence performance. We know that work schedules and training and experience influence performance.

These are all called Performance Shaping Factors (PSFs). We use them all the time to predict human performance. So, we know the factors that influence behavior. We know if we ask people to do a complicated, high-precision task in a noisy, cluttered environment, they are more likely to make an error. We may not know exactly when or who or what, but that error is more likely.

IMPORTANTLY, THESE FACTORS CAN ALSO BE MANAGED!

Predicting Team Performance

Human Factors & Teams

CAN YOU PREDICT...

TEAM BEHAVIOR?

Bennett, 1/30/98, ##   Our Goal for Today is to Have Zero Human Errors
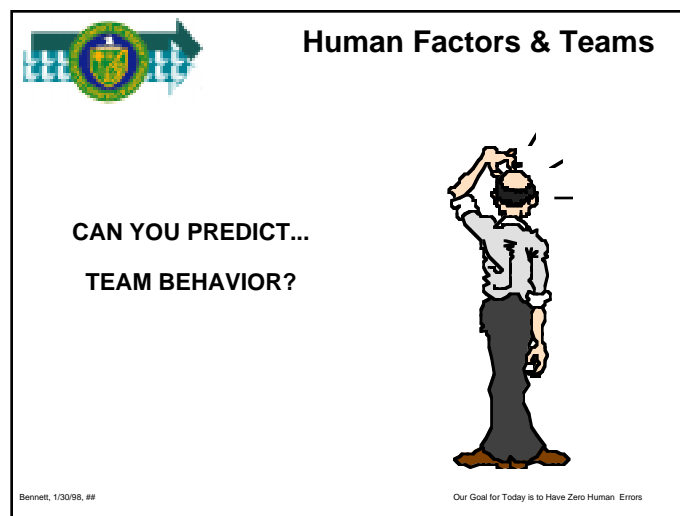
Would you bet on the 49ers? What about the Raiders? Teams are not the same as a group of people doing their separate tasks individually.

You can use the technical competencies of individuals to help predict team performance. But it's not perfect, because comparing team tasks with individual tasks is truly like comparing apples and oranges. A team task is two fire control officers, sitting twelve feet apart, turning the key simultaneously to fire a missile. This is out of the realm of individual performance. It is a pass play (football equivalent for sequential tasks on the floor). There is a thrower and a receiver. It is not an individual task.

As with individual behavior, there are PSFs for teams. What are some? Individual proficiency, team training. Also there are incentives—bonuses for playoff games or for meeting the contract goals. Any one individual can blow it. In these cases, individual success has no significance. If one fails, everyone fails.

We can shape and predict team performance here in AVLIS. We have not done all we can do yet. An individual should not be held solely accountable if in fact it was a team's responsibility (workers, trainers, managers, everyone in an organization). We should not hold the team responsible if we haven't provided appropriate team training.

In the case of the venting incident (which we will talk about in a moment), root cause analysis was initially misdirected, and it had us nail the supervisor. It did not lead us to the fact that there was a breakdown in team responsibilities or the fact that we did not have Team Resource Management.

So, just as with individuals, we can generally predict team performance. Maybe not exactly, but research (commercial aviation and the military) has shown that if we train people in their individual skills, and then train them to interact as a team, they are less likely to make an error.

If we just assume a team knows how to act as a team, we are ultimately setting them up for failure.

2.2.6 Learning Criteria   Be able to accurately discuss PSFs.

2.3   Culture, Norms, Values, and Attitudes

2.3.1	**Time Schedule and Materials**	9:55—20 minutes

VG21—What's a culture?

VG22—Procedures and professionalism

VG23—Supervisors' roles and responsibilities

VG24—Individuals' roles and responsibilities

VG25&26—Team Attitudes and the easy way to shape them

Video—"Crash Detectives," 1:16.25–1:32.45, Cargo Door, 6 minutes.

2.3.2	**Subject**	Discuss the relationship of culture, norms, values, and attitudes. Describe the importance of defining roles and responsibilities within teams.
2.3.3	**Objectives**	Describe how procedures relate to culture, norms to techniques, basic team processes.
2.3.4	**Methods to be Used**	Lecture and discussion.
2.3.5	**Content**	There are several definitions of culture. Culture refers to the sum total of the ways we live and work. For simplicity, I will refer to culture in terms of the documented way we do business. It is the physical things that we use to transmit our values and the way we go about doing the work we do. Our procedures are our physical culture.
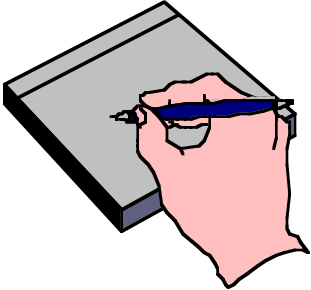
Culture and Norms

Human Factors & Teams

Our Culture and Norms...

- We have to ESTABLISH A FORMAL PROTOCOL for working as a team...
  - CULTURE and NORMS shape our behavior
  - Our culture is our totems
    - If it's NOT DOCUMENTED, we have NO CULTURE
  - Structured, agreed upon norms are positive ways of controlling activities that do not have procedures

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But, everything about the way we live and work cannot go into our physical culture; that's where norms come in. We will refer to norms as the undocumented, accepted way we do business, the way we implement our physical culture (procedures). Both are important. Our culture would eventually disappear unless we documented it.

But, if we do not pay attention to our norms, we will be tripping over ourselves. In dancing, the physical culture would be the steps painted on the floor. The norms would be how Astaire and Rogers implement that dance. It is the technical technique and the style that literally keep them from stepping on each other's toes.

Structured, agreed upon ways of conducting activities that have no procedures are a positive way of doing business...and, a part of TRM.

Reliability and Procedures

It became clear in aviation that reliability and safety was being compromised by an informal use of procedures for high risk operations. (An example of negative norms.)

Remember that risk is defined as consequence times probability. Aviation knew that takeoff procedures were high consequence, but they did not do anything to formalize the norms until there was a number of takeoff accidents (i.e., the probability was going up).

Pilots were so stubborn about how to implement procedures,

it took fatalities, crashes, and regulations to formalize the process. (An example of positive norms.)

We should look carefully at the formality of our procedure norms.

Leader's Roles and Responsibilities
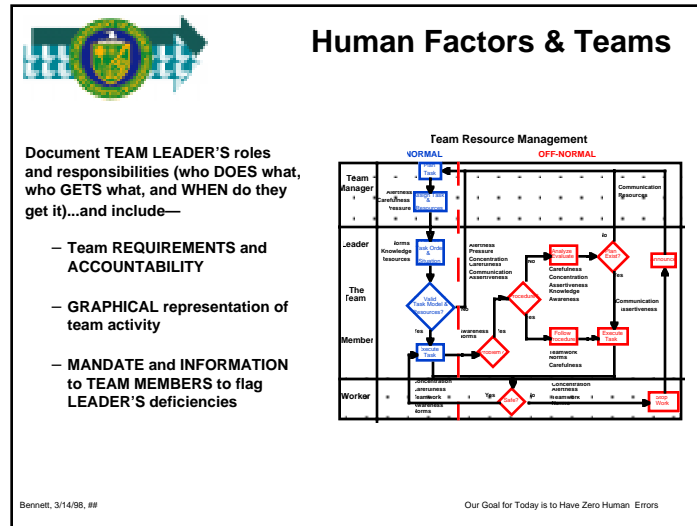
The leader's roles and responsibilities are generally shown in the upper part of the figure. These are the positive norms that you should see in a team.

The leader clearly defines what is expected, plans for resources, and evaluates the situation. The leader iterates with the team members on the execution of the plan.

This process also mandates that the team members understand what is expected of the leader and question the leader when those expectations are not met.

Team Member's Roles and Responsibilities
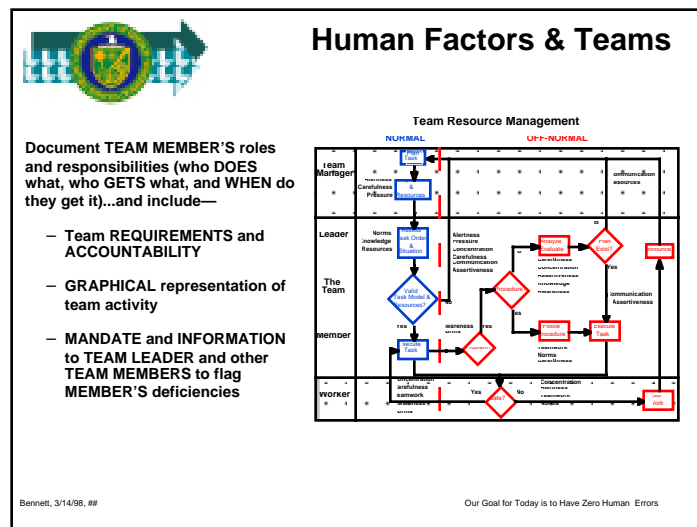
The member's roles and responsibilities are generally shown in the middle part of the figure. These are the positive norms that you should see in a team.

The members carefully confirm their roles and responsibilities in a given task. The members iterate with the leader on the execution of the plan.

This process also mandates that the team members understand what is expected of the leader and other team members and question the leader and other team members when those expectations are not met.

Team Attitudes
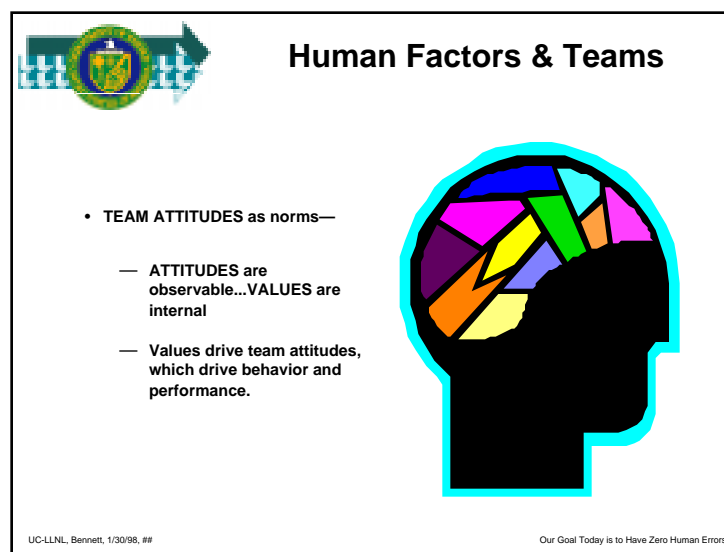
For the most part, attitudes are observable. Some say that 90% of the way we communicate attitudes is non-verbal. Attitudes reflect our personal feelings about work, the people around us, and our life in general. They influence how we act and behave.

Values are private. The only way we know about them is if we ask someone, or we can infer what people's values are from their attitudes (which are observable) or from their actions (which are observable). Generally, it's considered that values influence attitudes, which influence our behavior.

As with individuals, team attitudes influence team performance. Team values influence team attitudes, which drive behavior and performance. Attitudes and values are an important part of Team Resource Management. How can we manage these important concepts?

The Easy Way
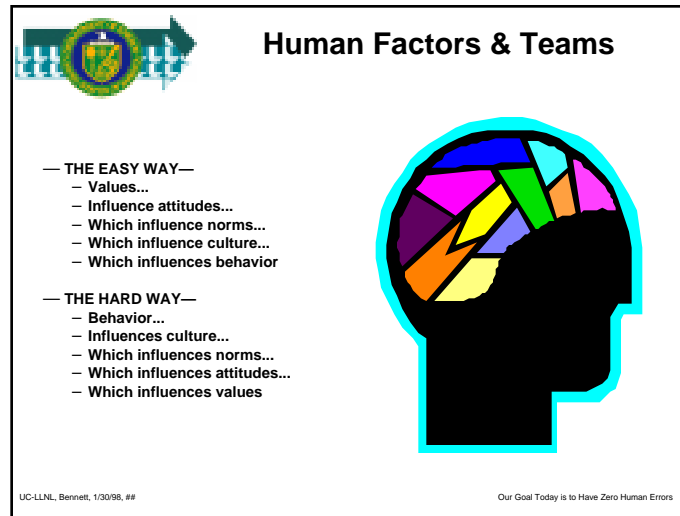
The Easy Way. Generally, values people have are very enduring and resistant to change. That's why we try to hire people with the right work ethic and who value the same things we do.

The Hard Way. We can constrain the way people act and behave by forcing culture and norms down their throats. This is like telling people that they have got to do it this way or else. Research has shown that this process can shape peoples' attitudes and their values. The hard way can work....it's just that it's...well, hard.

For example, we told all people who are going to work in Building 490 that they needed to submit a work authorization plan, something they had not done before. This was because they did not value communication with us before they started work. Well, it did cause some hard feelings at first. But, people started to see the importance and value in communicating early in the work process.

We would like to influence values in a "kinder, gentler" way. But, sometimes that is just not possible.

It is important to remember that the information flow from values to behavior is not one way. There are many feedback and feedforward loops that work in parallel and in series. What Team Resource Management does is to help the value-behavior control loops work efficiently.

2.3.6 Learning Criteria

Correctly answer questions concerning culture, norms, and team roles and responsibilities.

2.4 I'm only a....

2.4.1 Time Schedule and Materials

10:15—5 minutes.

VG27&28—What's a mechanic? What's professionalism?

2.4.2 Subject

Characteristics of mechanics and professionalism.

2.4.3 Objectives

Describe mechanics' characteristics and team responsibilities and define professionalism.

2.4.4 Methods to be Used

Lecture and classroom discussion.

2.4.5 Content

Here is a list of characteristics that was collected in a study of aircraft maintenance technicians, some of the most skilled mechanics around, people not unlike yourselves. These were developed from a study of aviation mechanics. Some of them would suggest that mechanics are loners and are not necessarily "team" players. This may be right. And, that is why aviation feels so strongly about TRM.

Professional Mechanic

When is the last time someone asked you where you work, and you told them at LLNL. And, they asked you what you do; and, you said, "I'm just a technician." Well, there are few people in the world who do what you do. Most work in high-consequence settings and take a great deal of pride in their work....which they should!

Exercise   Have two of the trainers get up and start walking toward each other.

First Trainer: "Hi, Joe. Haven't seen you in a long time. Are you still working at the Lab?"

Second Trainer: "Yeah, I've been there almost ten years now. It's been a long time since we've seen each other!"

First Trainer: "I can't remember what you do there. You an engineer?"

Second Trainer: (Hanging his/her head) "Nah. I'm just a technician...."

The point to be made here is that our technicians are some of the most highly skilled people who work in some of the highest technology, and most dangerous, settings in the world. They should, in fact, be proud of what they have accomplished.

One of the most important things to remember is the importance of professionalism in our jobs. Teams are dependent on technically proficient people as much as professional people. Professionalism says something about our norms (how we go about our undocumented work), our attitudes (how we perceive and react to the world around us), and our values (the things we hold important).

For example, confusion, juggling too many tasks, getting in over our heads—these are not marks of professionals.

Professionalism

There are two general parts to professionalism: individual and company-related.

Individual professionalism deals with how you view your technical job, the work standards you use, the goals you set for yourself, the use of "best practices" and norms.

Company-related professionalism deals with how you view your company's goals and standards, what you do to ensure they are achieved, and how you view yourself as an extension of the company.

For example, you stay on top of the technical aspects of your job, always trying to move to the next level, and being formal about your work habits. You are concerned about the company's goals and how your behavior at work and off duty reflect on the company.

Are you professional off duty? For example, an engineer is rude at a store, and because of his "rotor beanie" cap, the sales person correctly concludes the engineer works at the Lab. At the next election, the person decides not to vote for a candidate who supports the Lab. The candidate is defeated, and the opponent cuts Lab funding.

You have to make that judgment about how to balance your professionalism with all the other demands in your life. Research has shown that people who are the most successful are the ones who have learned how to optimize

work and family demands. To them, it is not a question of family or work. It is a question of family and work.

**2.4.6 Learning
   Criteria**   Correctly answer questions concerning professionalism.

3. Introduction to the Dirty Dozen, #1-Communication, #2-Carefulness, #3-Knowledge, #4-Concentration, #6-Alertness 10:30-11:45

Summary of Unit 3 Schedule.

Section	Time Allotted 75 minutes
3.1 Introduction to the DD	35 minutes—5 VGs, 30 minute video ("Canadian AF DD")
3.2 #1 Communication	15 minutes —1 VG
3.3 #2 Carefulness	10 minutes —1 VG, 6 minute video ("Crash Detectives," 1:13.25–1:15.16, Wrong Engine)
3.4 #3 Knowledge	5 minutes —1 VG
3.5 #4 Concentration	5 minutes —1 VG
3.6 #6 Alertness	5 minutes —1 VG

3.1 The "Dirty Dozen" and Our 12 Rules-of-Thumb...Finding the Balance

3.1.1 Time Schedule and Materials

10:30—35 minutes

VG29—Summary of the heuristics

Transport Canada's video—"Canadian AF DD," 30 minutes

3.1.2 Subject

Introduction of Dirty Dozen (DD) and the 12 rules-of-thumb.

3.1.3 Objectives

Identify the twelve DD and discuss the purpose of safety nets.

3.1.4 Methods to be Used

Lecture discussion and video tape.

3.1.5 Content

The affects of TRM were studied at a major airline by NASA and USC. Their findings were:

- Cost of repairs due to maintenance-related damage decreased 68%.

- Number of maintenance-related incidents were down 34%.

- Occupational injuries were down 21%.

- Occupational injury-related costs were down 12%.

The Dirty Dozen

Human Factors & Teams

Clues To Enhancing Your Reliability & Safety
The Twelve "Rules-of-Thumb" of Team Resource Management

Look for these clues before an incident happens...

1. Communication
2. Carefulness
3. Knowledge & Task Experience
4. Concentration
5. Teamwork
6. Physical & Mental Alertness
7. Necessary Resources
8. "Time-Out" to Pressure
9. Assertiveness
10. Effective Stress Management
11. Situational Awareness
12. Positive Group Norms

(Adapted from Kennedy Space Center.)

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors

Supervisors can have control over many of the Dirty Dozen.

They can create pressure, distraction, and stress. Conversely, they can take steps to minimize them. As we will see, workers also can control them.

To be cost effective and to be able to quickly respond to the needs of our customers, we must work in a distributed control system. While the military is often viewed as strictly hierarchical, over the centuries it has perfected distributed control as an organizational process management tool. Distributed control provides for global constraints ("Go set up a defense between that hill and the river"), but depends locally on individuals implementing the specifics (fields of fire, etc.).

"Globally constrain. Locally determine."

Distributed control works if all levels in the hierarchy have an accurate shared model of what the goal is and what needs to be done. Distributed control works if it clearly defines the roles and responsibilities of the individuals, and it works if, through practice and experience, the different hierarchical levels in a distributed control system come to trust each other.

Team Resource Management is the process that ensures distributed control will work—shared model, clearly defined roles and responsibilities, trust.

The twelve clues to ensuring reliability and safety are the twelve heuristics (rules-of-thumb) of Team Resource Management. The clues were adapted by the Kennedy Space Center's Human Factors Team from Transport Canada's Dirty Dozen.

3.1.6 Learning Criteria   Correctly answer questions concerning the DD.

3.2   Communication   (DD's #1 Lack of Communication)

3.2.1 Time Schedule and Materials 11:05—15 minutes

VG30—Communication

3.2.2 Subject Role of communication in team performance and procedures.

3.3.3 Objectives Describe how communication can break down and the safety nets that can be used.

3.3.4 Methods to be Used Lecture and classroom discussion.

3.3.5 Content It is estimated that breakdown in communication is the most significant contributor to human error. In high-consequence, high-reliability settings, communication has become very formalized to avoid ambiguity. It takes training. It takes practice.

#1 Communication
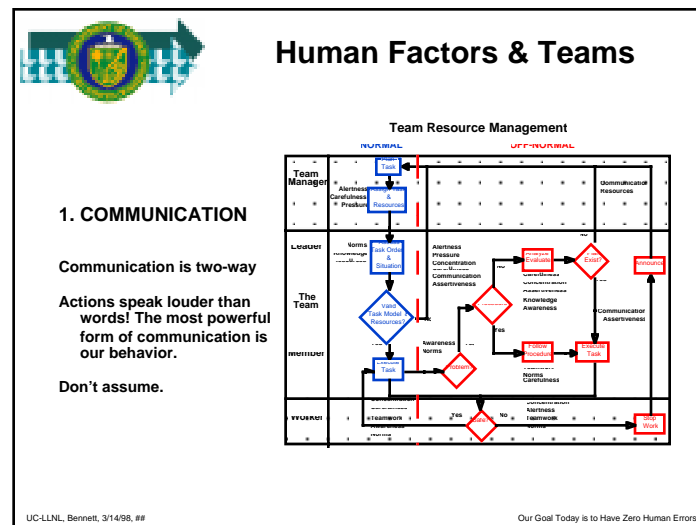
How do we communicate? Scientists say that:

- Words contribute 7%...
- Tone of voice 38%...
- Body Language 55%....

An exercise in body language communication:

Exercise Stand in front of the class, stick your arms out to the side and have the students do the same. Then say, "Put your finger on your chin." (But, put yours on your cheek. Many will follow what you do, not what you say.)

	As they say about effective communication, "You have 2 ears, 2 eyes, and 1 mouth. Use them in that order and proportion."
Scenario:	Unintended Copper Light Delivery.
People:	Several technicians and supervisors. All were qualified and experienced.
Job:	Conduct Quarterly Interlock Check (QIC) on the Copper Laser System.
What Happened:	While performing the QIC, high-powered copper light was delivered into both dye sets one and two. The dye sets were not in an operational configuration at the time, and it was believed by the individuals who were performing the QIC that the copper laser system configuration would not allow delivery of any copper light. The portion of the QIC that was being performed during the incident was a test of the seismic detectors. According to the procedure, all shutters are directed to be open.
Problem:	There was an apparent breakdown in communication during this step that resulted in delivering the third corridor amplified copper laser chains to the dye sets. This caused the generation of 100% amplified spontaneous emission in all four dye chains for a period of at least 20 minutes. While no one was injured, this presented a serious potential for injury, since no light propagation was intended or expected. Operation of the dye chains in this manner potentially damages dye amplifiers, fiber-to-amplifier relays, fiber optic faces, and waveform generator components.
Safety net:	Complex systems require very structured communications. Determine the state the system needs to be in to operate or be maintained safely. Then establish a communication protocol that clarifies that state in everyone's mind. Don't assume. Ask.

Dirty Dozen's Safety Nets:

- Use logbooks, worksheets, etc. to communicate and remove doubt.

- Discuss work to be done or what has been completed.

- Never assume anything.

3.2.6 Learning Criteria	Correctly answer questions concerning communication safety nets.

3.3 Carefulness (DD's #2 Complacency)

3.3.1	**Time Schedule and Materials**	11:20—10 minutes
		VG31—Carefulness
		Video—"Crash Detectives," 1:13.25–1:15.16, Wrong Engine, 6 minutes
3.3.2	**Subject**	Role of carefulness in the breakdown of team performance and the safety nets that can be used to mitigate against it.
3.3.3	**Objectives**	Describe how carefulness can break down and the safety nets that can be used.
3.3.4	**Methods to be Used**	Lecture, discussion, and play acting.
3.3.5	**Content**	You've done the task a thousands times. Why should it be any different today? A check is the hallmark of professionalism. You shut a lathe down before lunch. When you come back, you can't assume nothing has changed before you get on with the work. If you're concerned that you won't finish before quitting time, think how late you'll be if you get hurt. Be professional and go through the start up procedure again. Good project planning will incorporate the time it takes to conduct these operations.
		Complacency is often linked with **Expectancy**, where a technician will often see what he or she expects to see rather than what is actually there. If other factors are present such as fatigue, a shortage of resources, and/or stress (from different sources), the chance for error becomes even greater. (From United Airlines' TRM course.)

#2 Carefulness

Scenario: High voltage shock.

People: One technician, an engineer, and a supervisor. The supervisor was monitoring the operation. The technician was qualified.

Job: Repairing the pulsed power emitter tank. The technician proceeded to fill the tank with Freon so it could be tested. The tank was then turned on, running into the dummy load. The engineer and technician were having a discussion about how to get the peaking current signal out to the oscilloscope.

What Happened: The technician leaned over the work station to see if he had plugged in the correct grid-driver output cable in the PPE tank. When he put his hand on the power supply to lean over the work station, he got shocked and was stunned.

Problem: People were thinking about one task (getting the signal out) and started to do it without reviewing how the task should be done.

Safety net: Know the high risk points in the operation. The operation of getting the signal out was a separate task that should have been reviewed for safe, reliable operations.

                       Dirty Dozen's Safety Nets:

                       • Train yourself to expect to find a fault.

                       • Never sign for anything you didn't do.

3.3.6 Learning   Correctly answer questions concerning carefulness safety
      Criteria   nets.

3.4 Knowledge and Task Experience (DD's #3 Lack of Knowledge)

3.4.1 Time Schedule and Materials

11:30—5 minutes

VG32—Knowledge and Task Experience

3.4.2 Subject

The role of knowledge in supporting team performance and the safety nets that can be used to mitigate against its breakdown.

3.4.3 Objectives

Describe how knowledge can break down and the safety nets that can be used.

3.4.4 Methods to be Used

Lecture and discussion.

3.4.5 Content

Technical information is often assumed. Professionalism is founded in the routine, ensuring you have all the facts and tools prior to starting a job.

#3 Knowledge and Task Experience
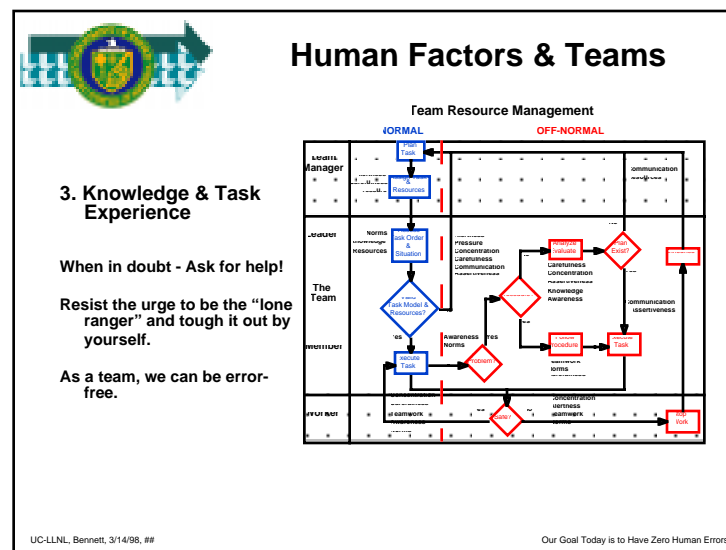
Professionalism is also founded in knowing your limitations. When was the last time you did this job? Just because you are technically qualified, considering all the task conditions, is this job right for you?

Scenario: Cut finger incident.

People: Technicians who were not a qualified to conduct the
                       operation.

Job: Sectioning a melt of uranium from the pod.

What Happened: During donning, technicians realized they did not have the
                       required leather gloves and asked someone to get some. The
                       person was taking too long, and the technicians put on some
                       vinyl gloves so they could get on with the job. While lifting
                       a sectioned melt, a technician cut his finger, which resulted
                       in a radiological exposure. The person who went to get the
                       gloves showed up about the time the ambulance arrived.

Problem: Technician was not qualified, but had done the operation
                       before. New lead technicians, who had assigned the task to
                       him, assumed he was qualified. They did not ask or check
                       the records. The technician never mentioned his lack of
                       qualifications because he thought he knew how the task was
                       done.

Safety net: Never assume you know how a high-consequence task is to
                       be done. Check training records as a lead technician.
                       Technicians should check to make sure they have been
                       qualified on the task and let the supervisor know if they
                       aren't. Check local inventories to make sure protective
                       equipment is at each station.

                       Dirty Dozen's Safety Nets:

                       • Get training on specific equipment.

                       • Use up-to-date manuals.

                       • Ask a Tech. Rep. or someone who knows.

3.4.6 Learning   Correctly answer questions concerning knowledge safety
         Criteria nets.

3.5   Concentration (DD's #4 Distraction)

3.5.1   Time Schedule and Materials   11:35—5 minutes

VG33—Concentration

3.5.2   Subject   The role of concentration in supporting team performance and the safety nets that can be used to mitigate against its breakdown.
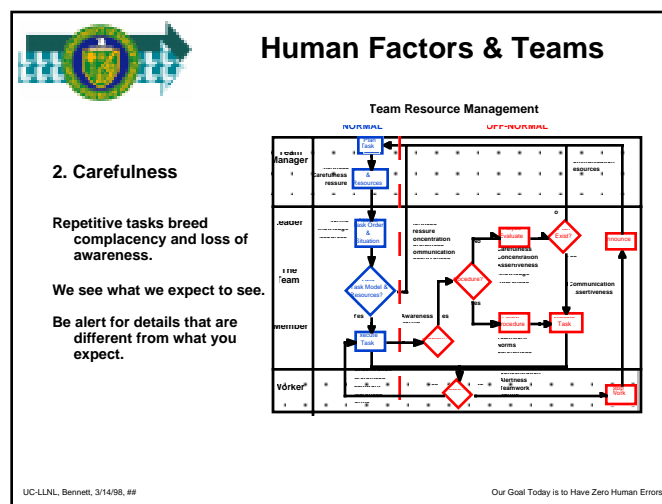
3.5.3   Objectives   Describe how concentration can break down and the safety nets that can be used.

3.5.4   Methods to be Used   Lecture and discussion.

3.5.5   Content   Know when your concentration levels are down and when you are easily distracted. If there are family problems, let your supervisor know that you would feel better if you have a backup for the job you are doing that day. This is what makes a team more robust than individuals working by themselves.

#4 Concentration
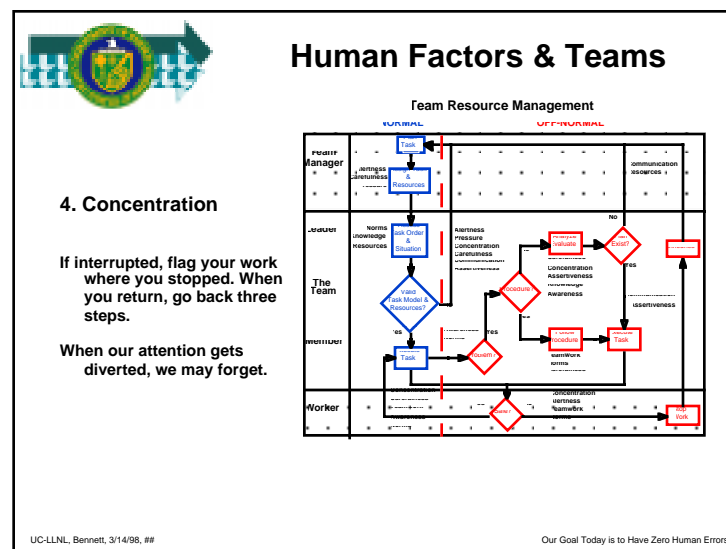
Using a detailed checklist is the mark of a professional. Cowboys try to wing it. We cannot afford to be cowboys. If called away from a job, mark where you are. Have somebody else check the details.

Scenario: Missed step.

People: Qualified technicians and supervisor.

Job: Doing routine assembly tasks in the High Average Power Facility.

What Happened: During assembly, the procedure was being used, but notes were being taken on the back of the instruction sheets. The technicians were going back and forth, from the front to the back of the sheet. Later, it was noticed that a step had been missed.

Problem: During routine tasks, the slightest distraction can affect reliability and safety. If tasks are disrupted, concentration can be broken.

Safety net: Never assume you know where you were in a task. Check the status of the system. Anything can be a distraction, from taking a break to a co-worker stopping to ask a question. Concentrating on the task AND the safety nets will make the reliability and safety of a job more robust.

                         Dirty Dozen's Safety Nets:

                         - Always finish the job or unfasten the connection.

                         - Mark the uncompleted work.

                         - Lockwire where possible or use Torqueseal.

                         - Double inspect by another or self.

                         - When you return to the job always go back three steps.

                         - Use a detailed check sheet.

3.5.6 Learning   Correctly answer questions concerning concentration safety
      Criteria   nets.

3.6   Physical and Mental Alertness (DD's #6 Fatigue)

|		
3.6.1	**Time Schedule and Materials**	11:40—5 minutes **VG34—Physical and Mental Alertness**
3.6.2	**Subject**	The role of alertness in supporting team performance and the safety nets that can be used to mitigate against its breakdown.
3.6.3	**Objectives**	Describe how alertness can break down and the safety nets that can be used.
3.6.4	**Methods to be Used**	Lecture and discussion.
3.6.5	**Content**	One of the insidious problems in the management of fatigue is that the more and more fatigued we become, the harder and harder it is to manage.

#6 Physical and Mental Alertness
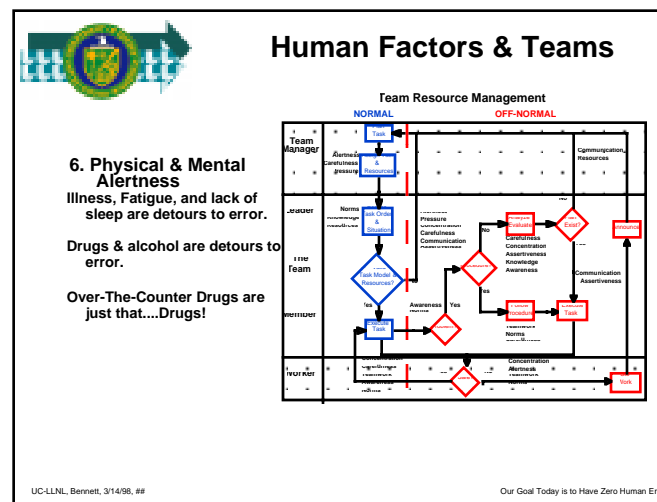
What do the Challenger, Exxon Valdez, and Bophal accidents all have in common? They all occurred at night. These are high-risk times of the day...even for people who have become "adapted" to night schedules.

There are daily biological rhythms that all of us experience and that affect our performance. Most of us start to experience degraded performance during late afternoon. The biological neurological reasons for this are complex, but very real.

When we are conducting high-consequence operations, we need to appraise our current status. In aviation, pilots are taught to do the "I'M SAFE" check before takeoff:

Illness—Am I healthy? If not, will the illness impact the reliability and safety of my work?

Medication—Am I taking any? Even over the counter drugs will affect my performance.

Stress—Did anything happen at home...on the way to work...that will affect my performance?

Alcohol—When's the last time I had a drink? (Aviation uses a twelve hour "bottle-to-throttle" rule of thumb.)

Fatigue—Have I gotten eight hours of sleep? If not, how much will my performance be affected?

Emotion—Are there any that will impact the reliability and safety of my work?

We are not talking about the obvious situations here, like when someone is an alcoholic. We are talking about the more subtle scenarios, like when someone has allergies and is taking over-the-counter medication that can make them drowsy. We are talking about the times someone is up late with his or her sick child.

Supervisors and lead technicians should do this check on a routine basis with all their employees. We will talk more about "I'm safe" during the section on Operational Risk Management.

Symptoms of Fatigue

Because the symptoms of fatigue come on slowly, it is important that we learn to recognize them and be aware of their effect. Often we are unaware that we are fatigued until the symptoms and effects have become extreme.

We are not just talking about how fatigue can lead to an accident on the job. If you are in an accident and get hurt during the commute home, the consequences are just the same as if you got hurt at work.

The following are symptoms to watch for (from United Airlines TRM workshop):

- **An enhanced stimulus is required in order to respond**.

  —The greater the fatigue, the greater the stimulus required.

  —A crack would have to be larger in order for us to see it.

- **Attention is reduced**

  —We begin to overlook basic task elements.

  —We become preoccupied with a single task to the exclusion of others.

  —We begin to reduce our visual scan.

  —We become less aware of poor performance.

Scenario:	Controls reversal during Demo 85.
People:	Senior engineer and several qualified technicians.
Job:	Aligning the e-beam.
What Happened:	After several long shifts to get ready for a run, the people involved tried to align the beam. The engineer kept wanting it to go one way, and the technicians kept pushing it the other way.
Problem:	The controls were labeled improperly. At first people didn't notice it. They kept trying to align the beam even after the incorrect labels were noticed. They were all tired.
Safety net:	Double check labels. Set rest cycles ahead of time.

Dirty Dozen's Safety Nets:

- Be aware of the symptoms and look for them in yourself and others.

- Plan to avoid complex tasks at the bottom of your circadian rhythm.

- Sleep and exercise regularly.

- Ask others to check your work.

3.6.6 Learning Criteria   Correctly answer questions concerning alertness safety nets.

4.   #7-Resources, #8-Pressure, #9-Assertiveness, and #10-Stress 13:00-13:50

Summary of Unit 4 Schedule.

Section	Time Allotted 50 minutes
4.1 #7 Resources	5 minutes —1 VG
4.2 #8 Pressure	10 minutes —1 VG
4.3 #9 Assertiveness	25 minutes —1 VG, 14 minute video ("Blaming the Pilot," 1:13.0–1:25.50, Tenerife), exercise on safety glasses
4.4 #10 Stress	10 minutes —1 VG

4.1   Necessary Resources (DD's #7 Lack of Resources)

4.1.1	**Time Schedule and Materials**	13:00—5 minutes
		VG36—Necessary Resources
4.1.2	**Subject**	The role of resources in supporting team performance and the safety nets that can be used to mitigate against its breakdown.
4.1.3	**Objectives**	Describe how resources can break down and the safety nets that can be used.
4.1.4	**Methods to be Used**	Lecture and discussion.
4.1.5	**Content**	Teamwork is crucial here. You use parts. Resource people need to make sure all the parts are there. Part of the grunge of being a professional technician is checking to make sure you have what you need to do the job. Gather all your tools and parts before work starts. Keep situationally aware of your tool and part inventory levels. Order ahead of time. If you don't have it, don't improvise the job with a "kludged" tool or part. Order tools and parts by technical specification and not part numbers.

#7 Necessary
      Resources
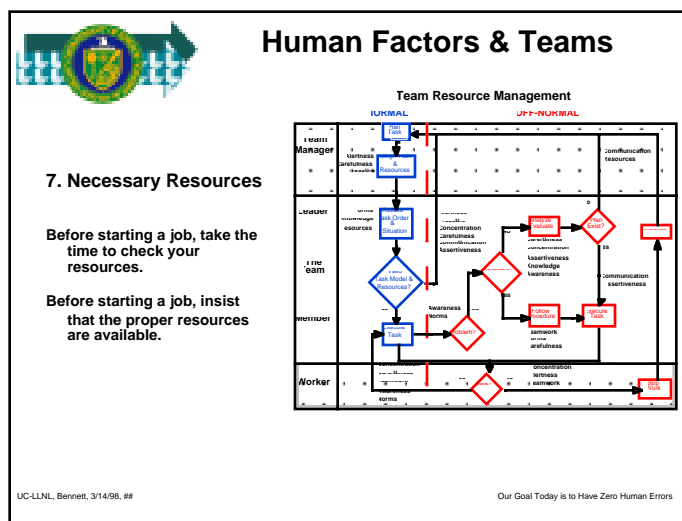
The lack of, or improper use of, resources (tools, equipment, information, etc.) has been the cause of many accidents. Technicians can be notorious for making do with less than adequate resources to get the job done.

In fact, some technicians view themselves as "a person who learns to do more and more with less and less until he/she is fully qualified to do everything with absolutely nothing." These are comments United Airlines makes when talking about lack of resources in their TRM workshop.

Scenario: The failed array.

People: Senior engineer and several qualified technicians.

Job: Assembling the array.

What Happened: During assembly, it was noticed that some of the available parts of the array were the wrong length. A judgment was made that the array would make it.

Problem: Due to schedule demands and availability of material, all array components were not available.

Safety net: During program scheduling, risk assessments need to be made, which balance procurement and assembly times against run dates.

Dirty Dozen's Safety Nets:

- Check suspect areas at the beginning of the inspection to determine what is needed.

- Order and stock anticipated parts before they are required.

- Know all available parts sources and arrange for pooling or loaning.

- Maintain a standard and if in doubt stop work.

4.1.6 Learning Criteria   Correctly answer questions concerning resource safety nets.

4.2 "Time-Out" to Pressure (DD's #8 Pressure)

|		
4.2.1	**Time Schedule and Materials**	13:05—10 minutes

VG37—Time-Out to Pressure

4.2.2 Subject

The role of "time-out" to pressure in supporting team performance and the safety nets that can be used to mitigate against its breakdown.

4.2.3 Objectives

Describe how resistance to pressure can break down and the safety nets that can be used.

4.2.4 Methods to be Used

Lecture and discussion.

4.2.5 Content

In our work, the program schedule will come back to bite us if not planned well in the beginning. Too often, schedules only incorporate program requirements. A program manager sometimes forgets low-level waste clean up, time for machine set ups and test runs, training, tours, honest mistakes. Get buy off from management to incorporate these into the schedule before agreeing to a task. Supervisors need to budget overhead tasks.

#8 Time-Out to Pressure
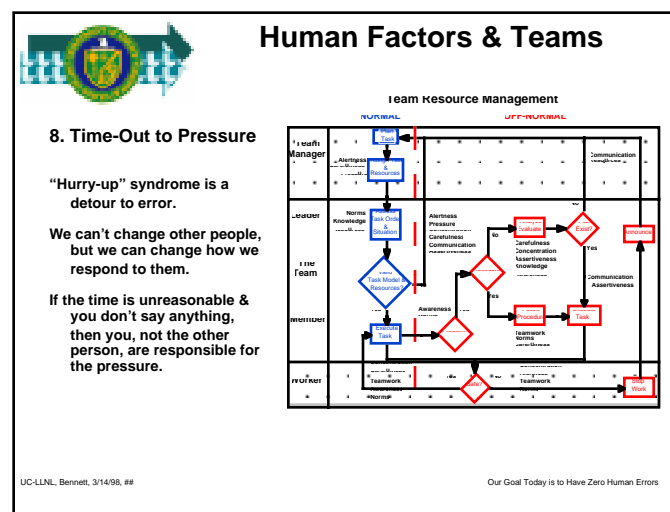
United Airlines cautions their mechanics in the following way about pressure. In most cases, the pressure we feel with a job comes from within ourselves. The boss may say, "I need this job completed by shift end." However, if the time frame is unreasonable, and you don't say anything, then you, not the boss, are responsible for the pressure.

When confronted with pressure,

- **Stop** and assess the situation.
- **Look** at the situation rationally.

  —What is the reality of the situation? Can I safely complete the work on time?

  —Have I communicated my concern in a concise and rational way?

  —What is the worst thing that could happen to me?

- **Listen** to your rational mind.

  —Has this happened before and what can I do better?

  —What is the best rational plan?

- **Act**—Speak up and ask for help or extra time as required.

Scenario:	Wrenched Back.
People:	Qualified, experienced laser electro-optics technician.
Job:	Fill nitrogen dewar and move it to a transporter.
What Happened:	To avoid wasting time, the technician did not wait for help and severely wrenched his back. Filed workman's compensation suit.
Problem:	There was a tight schedule and the technician was impatient.
Safety net:	We all get to the end of the day at the same time. There are tight schedules. But, that schedule is blown if you are hurt.

Dirty Dozen's Safety Nets:

- Be sure the pressure isn't self-induced.
- Communicate your concerns.
- Ask for extra help.
- Just say no.

4.2.6   Learning Criteria   Correctly answer questions concerning pressure safety nets.

4.3   Assertiveness (DD's #9 Lack of Assertiveness)

4.3.1	Time Schedule and Materials	13:15—25 minutes

VG38—Assertiveness

Video—"Blaming the Pilot," 1:30.0–1:25.50, Tenerife, 14 minutes

| 4.3.2	Subject	The role of assertiveness in supporting team performance and the safety nets that can be used to mitigate against its breakdown.
4.3.3	Objectives	Describe how assertiveness can break down and the safety nets that can be used.
4.3.4	Methods to be Used	Lecture, video, and discussion.
4.3.5	Content	If we encounter a programmatic problem with an engineering lead, or a safety problem with our co-workers, we must walk a tightrope when we try to communicate the problem. Will they think we are too uppity or bossy? Will they think we are acting like know-it-alls? Is it my job at all?

#9 Assertiveness
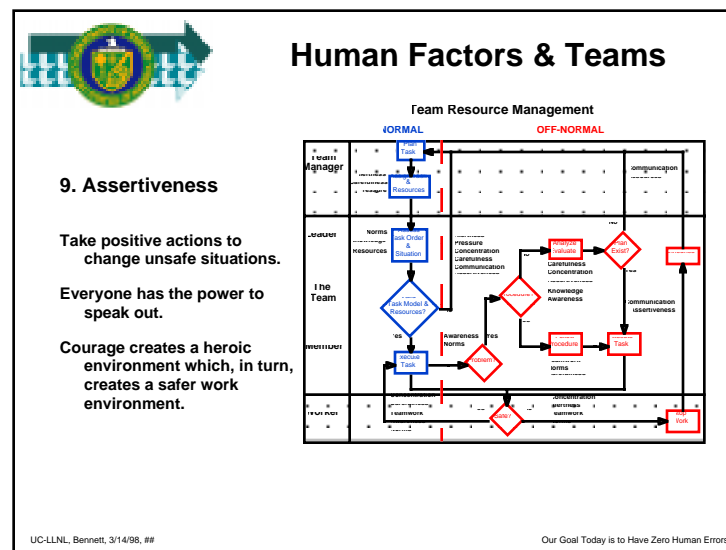
When there is a technical problem, don't just say there is a problem. Be specific, giving actual values and what the nominal values should be. If it is a safety critical system, you must know how to short circuit the system. Management has to provide those pathways and show by example that they are there.

Show video here. Afterward, point out that if it was hard for the Co-captain to try to stop the take-off at Tenerife; is it easier to get someone to put on his or her safety glasses.

Exercise

As an exercise, do the following: Tell the group that they've just seen someone working without their safety glasses on. Have each group individually list how they think someone would respond if they went up and asked them to put their safety glasses on. You should get responses like, "Who do you think you are, my mother." Then have them discuss how they would respond to that person. Use the principles in the guidelines presented below.

The following is from Transport Canada's course in TRM. The Bottom Line is:

You have to care more about the safety of your co-workers than about your own embarrassment.

- **Do not take too much responsibility for the other person's response**—You can only be responsible for doing what you think is right.

- **Do not jump to conclusions**—The response may not be negative, and the action may not have been intentional.

- **Prepare yourself emotionally**—Take a minute to calm down and get your thoughts collected. Your emotional state will influence the effectiveness of your feedback.

GUIDELINES FOR GIVING FEEDBACK:

- **Be specific**—If you are too vague, the person will not get your point.

- **Describe behaviors, not the person**—Do not attack an individual's personal worth. We see only behaviors, not intentions. (Say, "When I see you not wearing your eye protection, I worry about your safety." Not, "You are an unsafe person.")

- **Be objective and honest**—Keep personal biases and hearsay out of the feedback process. Care enough to give open and meaningful feedback even if it is difficult to do.

- **Show respect**—Check your motivation. Do you want to help or hurt? Providing positive motivation to improve reliability and safety enhances relationships. Using punishment as the initial response can hurt.

- **Do not overload with too much data all at once.**

- **Speak for yourself, not others**—Speaking for "the group" is unfair and counterproductive. The receiver is likely to feel "ganged up on" and will probably react defensively.

GUIDELINES FOR RECEIVING FEEDBACK:

- Clarify the data you receive—Ask for more information and/or examples if you are unclear on the feedback.
- Listen before you respond—Take extra time if you are feeling emotional.
- Look for the useful part of the feedback.
- Do not let defensiveness get in the way of listening and learning.

Do not debate, detour, plan your response, or tune **out.**

Scenario:	Crossing high-voltage danger signs.
People:	One involved a trained area worker, another involved an electronics technician (E-tech).
Job:	In the first case someone saw a worker who had crossed the roped-off area. In the second, the E-tech leaned across the rope to check to see if anyone was in the area.
What Happened:	No one was hurt. A senior E-tech found out about the incidents and brought a sign to a shift change meeting. He brought the danger sign (concrete example) and asked if everyone knew what it meant. (Laughter.) Then he explained exactly how if you cross into the roped-off area, you can get hurt even if you don't touch anything because you could be a point for the source to drain. This is TRM at its finest.
Problem:	The people who reported it should have stepped up and said something immediately. They had a hurry-up-and-get-it-done attitude.

Safety net: It takes courage to use shift change to disseminate safety information. Humor helps diffuse the situation. (People could have thought the E-tech giving a safety tip at the meeting was a know-it-all. They didn't.)

Dirty Dozen's Safety Nets:

- If it is not critical, record it in the journey log book and only sign for what is serviceable.

- Refuse to compromise your standards.

4.3.6 Learning Criteria   Correctly answer questions concerning assertiveness safety nets.

4.4   Effective Stress Management (DD's #10 Stress)

4.4.1   Time   13:40—10 minutes

                      VG39—Effective Stress Management

4.4.2   Subject   The role of stress management in supporting team
                      performance and the safety nets that can be used to mitigate
                      against its breakdown.

4.4.3   Objectives   Describe how stress management can break down and the
                      safety nets that can be used.

4.4.4   Methods to be   Lecture and discussion.
        Used

4.4.5   Content   Stress can have positive or negative influences. Chronic
                      stress will take the most significant debilitating toll. Chronic
                      stress is usually the type that you need help to manage
                      because it is often due to factors that you cannot control, or
                      you perceive that you cannot control them.

**#10 Effective Stress
Management**
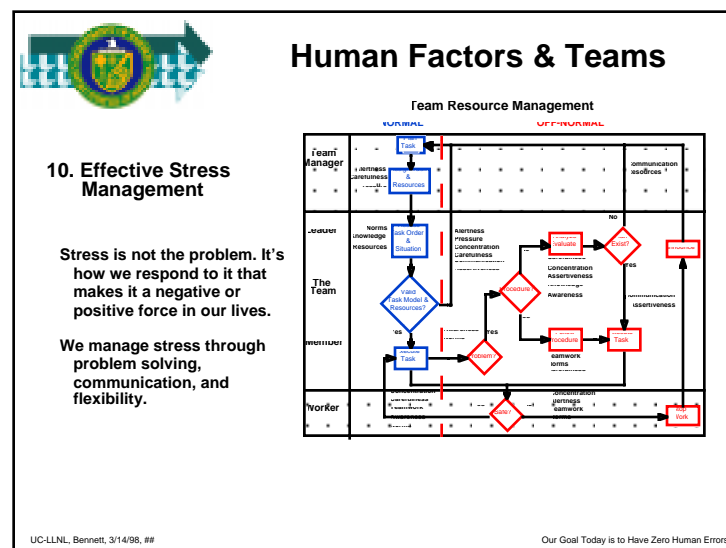
Acute stress is more manageable. You can take short breaks
at work. You can have fellow workers monitor your work
products. You can exercise.

Here are some suggestions about managing stress that
United Airlines gives to their mechanics.

There are three basic ways to cope with stress:

- Eliminate the stressor or change our response to it.
- Use the coping skills/resources available to us.
- Develop new coping skills/resources.

The major skills/resources needed for coping with stress are:

- Problem Solving.
- Communication.
- Flexibility.

Problem Solving focuses on our ability to deal directly with difficult situations we face and to make positive changes to resolve them. It builds on our creative skills and can be a useful resource to successfully cope with stress. Following are some suggestions for building problem-solving skills:

- **Solve it now.** Do not assume the problem will go away with time. It is easier to deal with problems before they become serious.
- **Define the problem.** Is what you perceive as the problem really the problem? What is the source of the problem?
- **Separate people from the problem.** What is the behavior that is causing the problem? Attack the problem, not the people.
- **Separate emotions from the problem.** Recognize and separate the emotions surrounding the problem from the actual issue at hand. This helps us make clearer decisions.
- **Determine your desired outcome.** What is your goal in solving the problem? If other people are involved, you must focus on shared interests and outcomes.
- **List a variety of creative and practical solutions.** Do not evaluate your ideas until the list is completed.
- **Do not get trapped into thinking there is only one resolution.** Try some new ways.

Scenario: Pod-Drop Incident.

People: Several supervisors, trained technicians, and a forklift trainee.

Job: Transfer the lower pod from B493 to B490.

What Happened: A trainee had requested that she use the transfer as a training experience. A "C" clamp was used instead of the usual system to hook the transfer cart to the forklift. The pod tipped off the cart. No one was hurt, nor was there any significant damage to the pod.

Problem: The driver had not traveled the route before. Supervisors gave verbal permissions without physically being present. People wanted to continue to meet schedule demands.

Safety net: Supervisors should have been present. Workers could have pressed the supervisors to be present. Drivers could have pre-walked the route with an experienced technician.

Dirty Dozen's Safety Nets:

- Be aware of how stress can affect your work.
- Stop and look rationally at the problem.
- Determine a rational course of action and follow it.
- Take time off or at least have a short break.
- Discuss it with someone.
- Ask fellow workers to monitor your work.
- Exercise your body.

4.4.6 Learning Criteria Correctly answer questions concerning stress management safety nets.

5. #11-Awareness, #12-Norms, #5-Teamwork, and ORM 14:00-14:50

Summary of Unit 5 schedule.

Section	Time Allotted 50 minutes
5.1 #11 Awareness	10 minutes—1 VG, 7-minute video ("Blaming the Pilot," 1:30.45–1:39.06, A320 crash)
5.2 #12 Norms	15 minutes—1 VG, 10-minute video ("Wing & a Prayer," 1:01.45–1:13.46, 747 design)
5.3 #5 Teamwork	10 minutes—1 VG
5.4 Operational Risk Management	15 minutes—5 VGs

5.1 Situational Awareness (DD's #11 Lack of Awareness)

5.1.1 Time Schedule and Materials   14:00—10 minutes

VG40— Situational Awareness

Video—"Blaming the Pilot," 1:30.45–1:39.06, A320 crash, 7 minutes

5.1.2 Subject   The role of situational awareness in supporting team performance and the safety nets that can be used to mitigate against its breakdown.

5.1.3 Objectives   Describe how situational awareness can break down and the safety nets that can be used.

5.1.4 Methods to be Used   Lecture and discussion.

5.1.5 Content   We work in a complex setting from a technical and regulatory perspective. We have engineers writing project instructions. We have facilities people writing Facility Safety Plans. We have compliance folks writing Occupational Safety Plans. Each use their own language, some of which maybe conflicting.

#11 Situational Awareness
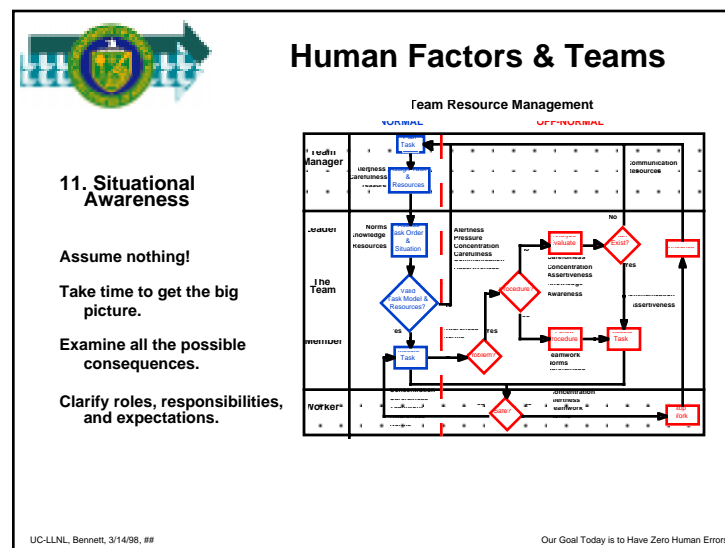
We must know the context of our task. You need to do maintenance on a pump. But, should you check on the affects on the system of turning it off? The more complex the system and higher the consequence, the more important it is to check.

Scenario: Loss of communication and a pump.

People: Experienced controls technician.

Job: Routine preventive maintenance on fiber optic cables used to control various systems.

What Happened: Due to operational considerations during routine maintenance, there was a break, and a technician decided to reseat cable terminators to ensure that they were making good contact. When one of the cables was pulled out, it shut down a pump that spewed oil into the vessel. No one was hurt, but it was a considerable mess to clean up.

Problem: The system was extremely complex. The technician thought he knew the current state of the whole system. The job had not been completely discussed with all personnel.

Safety net: The technician should have checked with a lead operator and told him/her what he was going to do. Never assume.

Dirty Dozen's Safety Nets:

- Think of what may occur in the event of an accident.

- Check to see if your work will conflict with an existing modification or repair.

- Ask others if they can see any problem with the work done.

5.1.6 Learning Criteria   Correctly answer questions concerning situational awareness safety nets.

5.2   Positive Group Norms (DD's #12 Norms)

5.2.1   Time Schedule 14:10—15 minutes.
and Materials

VG41—**Positive Group Norms**

**Video—"Wing and a Prayer," 1:01.45—1:13.46, 747 design,
10 minutes**

5.2.2   Subject   The role of positive group norms in supporting team
performance and the safety nets that can be used to mitigate
against its breakdown.

5.2.3   Objectives   Describe how positive group norms can break down and the
safety nets that can be used.

5.2.4   Methods to be Lecture and discussion.
Used

5.2.5   Content   Norms can be easier and quicker than written procedures.
Norms allow for flexibility and improvisation. Norms allow
for technique.

**#12 Positive Group
Norms**
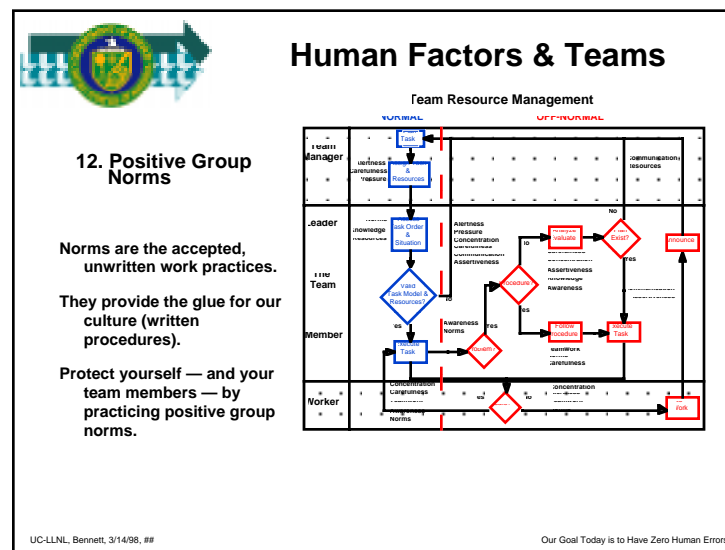
But, norms allow for confusion if not communicated
properly. Procedures always allow for some interpretation.
Think about the eleven other Team Resource Management
rules-of-thumb to guide your professionalism.

Scenario:	Laser alignment and near laser exposure.
People:	Several senior laser technicians.
Job:	Routine alignment and preventive maintenance.
What Happened:	During a period of shift overlap, a technician received permission from a laser lead technician to enter the East wall. The lead technician from the other shift was not aware of this and had control of the system. The technician entered the East wall and mistakenly shut the door behind himself, "making" the interlocks. The lead technician controlling the system, unaware that anyone was in the East wall, opened the end-of-chain shutters just as the technician was standing up, barely missing a retinal exposure.
Problem:	Informal procedures during shift turnover.
Safety net:	Have a standard shift change meeting with everyone and go over the day's operations, including a discussion of where people are going to be.

Dirty Dozen's Safety Nets:

- Always work as per the instructions or have the instructions changed.

- Be aware that "norms" don't make it right.

5.2.6 Learning Criteria   Correctly answer questions concerning positive group norms safety nets.

5.3   Teamwork (DD's #5 Lack of Teamwork)

5.3.1   Time   14:25—10 minutes

                          VG34—Teamwork

5.3.2   Subject   The role of teamwork in supporting team performance and the safety nets that can be used to mitigate against its breakdown.

**5.3.3   Objectives**   Describe how teamwork can break down and the safety nets that can be used.

5.3.4   Methods to be Used   Lecture and discussion.

5.3.5   Content   Technical people are often trained as individuals, and we pride ourselves in our individual skills. In our academic or technical training, very rarely do we think as a team, with team goals, values, attitudes.

#5 Teamwork
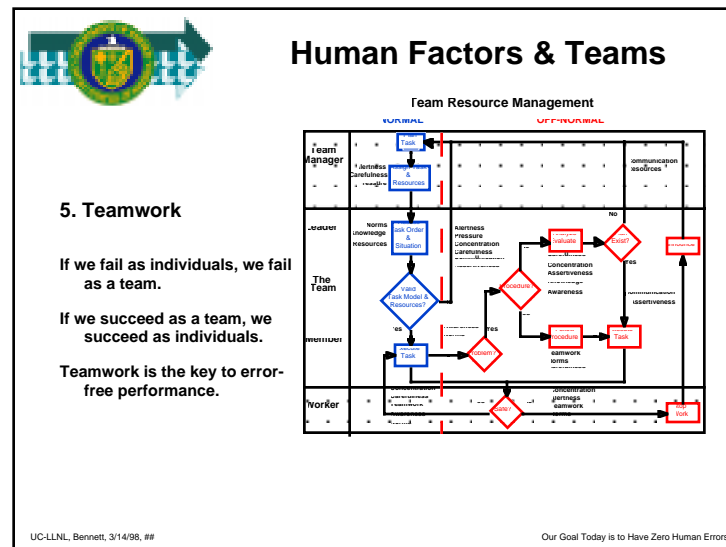
We must understand the task and what's going on around us. We must understand our roles and responsibilities as team members, not just as technical people.

Research shows that teams bring reliability and safety robustness only if the members know their roles and know how to communicate problems with task performance and safety.

Scenario:	Sweeping on the night shift.
People:	Several experienced technicians and supervisors.
Job:	Conducting routine tasks during a swing shift.
What Happened:	During the next day shift, it was realized that the required assembly tasks had not been completed. But, the facility was clean. Technicians said that no task instructions had been left.
Problem:	Clear, detailed, unambiguous task instructions were not prepared and conspicuously posted. Technicians did not check with supervisor about such a list.
Safety net:	The supervisor needs to clearly define roles and responsibilities. Team members have a mandate to challenge leaders about incomplete and ambiguous task lists.

Dirty Dozen's Safety Nets:

- Discuss what, who, and how a job is to be done.
- Be sure that everyone understands and agrees.

5.3.6 Learning Criteria	Correctly answer questions concerning teamwork safety nets.

5.4   Operational Risk Management (ORM)

5.4.1	**Time Schedule and Materials**	14:35—15 minutes.

VG42—Tricky jobs

VG43—Risk analysis

VG44—The five steps

VG45—The four rules

VG46—I'm Safe

5.4.2	**Subject**	ORM provides a way to conduct a "just-good-enough" risk assessment.
5.4.3	**Objectives**	Describe how ORM is used to support TRM.
5.4.4	**Methods to be Used**	Lecture and discussion.
5.4.5	**Content**	In the viewgraph is shown the Trinity device that was detonated at the first test. Work practices were not the best then. Sometimes we were lucky. But, as we said earlier, this is the period in history when we had most of the criticality accidents. Our work practices have improved, but can get better.

Risk on the Job

Human Factors & Teams

Sometimes Our Jobs Get Tricky!

And...When we work alone, sometimes the problems can seem very large.

Remember...We are always part of an extended team.

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors
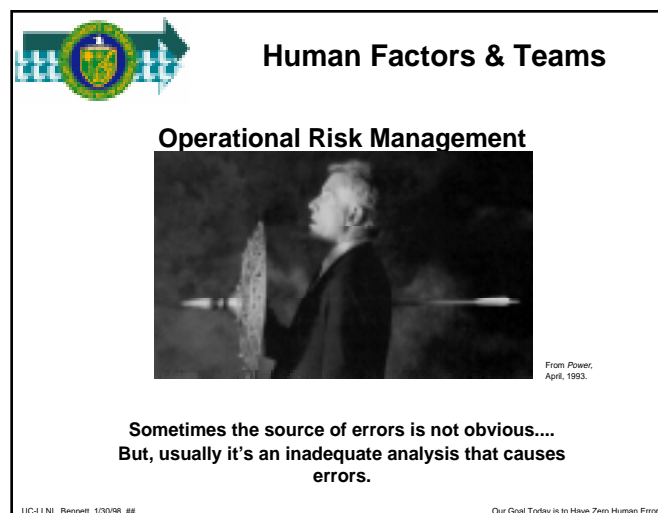
We have been trained well to work as individuals. There are techniques for working as a team. We need to take

responsibility for achieving our team goals. Our organization is less than perfect. It never will be perfect. Part of our responsibility is to achieve our goals despite those imperfections.

We are a part of an extended team. We are dependent on that extended team for many things, like program planning, resources, and training. If those goals are not being met we must look to the heuristics (rules-of-thumb) or safety nets in Team Resource Management to help solve the problems of our imperfect organization.

Risk Analysis

Human Factors & Teams

Operational Risk Management

From *Power,*
April, 1993.

**Sometimes the source of errors is not obvious....
But, usually it's an inadequate analysis that causes
errors.**

UC-LLNL, Bennett, 1/30/98, ##							Our Goal Today is to Have Zero Human Errors

Some of our systems are extremely complex; and, sometimes we get blind-sided by things that we could not have anticipated. However, research has shown that in some industries the majority of accidents could have been easily avoided with proper planning. That is, people started an operation without thorough preparation or without assessing current conditions and how those conditions could affect the operation.

Failure Modes Effects Analysis (FMEA) is an engineering tool used to help determine how a system might fail and what associated hazards are. This tool is directly applicable to our operations and procedures. An FMEA done on a procedure is a simple process of going through each step in the procedure and seeing the different ways in which an operator might make a mistake using the required equipment. Depending on the consequence of a failure, engineering or administrative initiatives are used to mitigate against the error.

This is a thorough process. But, for most normal operations it is impractical on a day-to-day basis. Decades ago, army ground operations had solved the problem of conducting rapid, thorough, "good enough" risk analysis and management. It is called Operational Risk Management (ORM) and has now been adopted throughout the aviation community.

The Five Steps
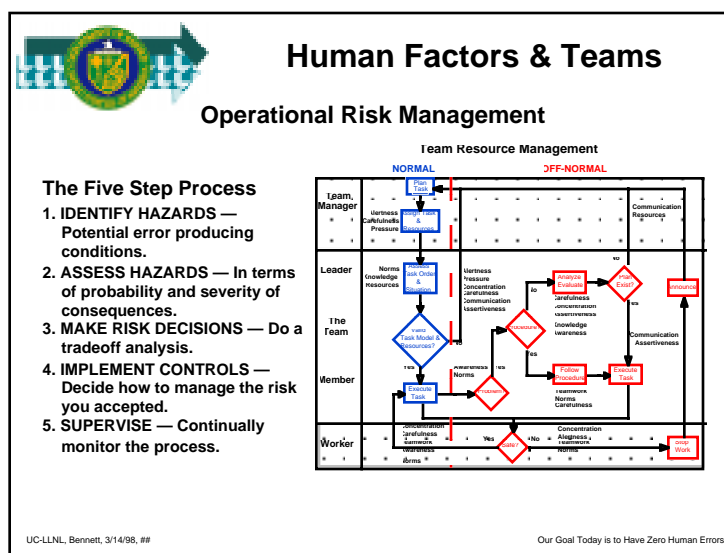
ORM is a very particular activity that is conducted as a part of the Team Resource Management process. ORM was formalized in the Army for ground operations, migrated to Army Aviation, then to Naval Air Operations. A very similar process was developed for commercial and general aviation and it has been called Aeronautical Decision Making (ADM).

Both ORM and ADM are conducted in a very similar fashion. They are conducted before every sortie in flight operations, and before every major maintenance operation. From a team perspective it takes discipline to conduct it every time you begin an operation, particularly if it is the thousandth time you have done it.

AVLIS Implementation:

Our current shift change is actually doing most of this right now. We do a high-level brief of the operation and current conditions. During shift meetings, we could easily, quickly step through ORM's five-step process. Most of the time it would be rather straightforward. But, for completeness, it would force us to at least "Consider the situation. What could bite us? How badly? Are there other ways to do it?

What are we going to do to mitigate the risk? How are we going to monitor it?"

As an aside, after taking a class at the Naval Postgraduate School, aviators have been seen sitting over their last beer at a bar on Friday night, saying, "OK, we know the potential error producing conditions are three pitchers of beer and a foggy night....mmm, maybe we should have another pitcher..."

The Four Rules
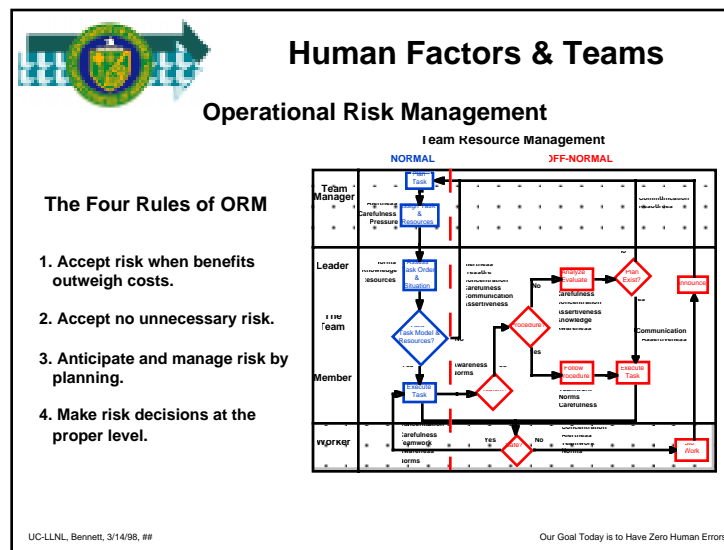
First Rule. Recognize that some degree of risk is associated with all operations and minimize and manage risk so that a task can be accomplished with minimal acceptable loss.

Second Rule. Take only the risks that are necessary to accomplish a task.

Third Rule. Address risks in the initial planning stage of a task when they are more easily managed. This is a rule of efficiency and economy.

Fourth Rule. Make decisions at the lowest level where the decision maker has the necessary information, experience, and authority to make a good decision. The level of approval should be commensurate with the level of risk accepted.

Scenario: Routine maintenance.

People: Supervisor and technician.

Job: Lock and Tag pump prior to routine maintenance involving an oil change.

What Happened: Lead operator was not present to authorize Lock and Tag. The technician went to the supervisor to get approval for the tagging. The supervisor was not completely sure of total system status and requested a walkthrough and analysis of the task. The technician was initially miffed that his supervisor challenged his knowledge of the task.

ORM Application: Each task or change in task needs to be assessed. It can take a few seconds or it may take days depending on complexity and the consequences.

Problem: The pump needed maintenance. But, because of the complexity of our systems, the risks were not completely obvious. Failure modes were assessed at the lowest possible level. The complexity of the Operational Risk Assessment matched the hazards and the consequences. Because it provides a systematic approach, Operational Risk Management is a "just-good-enough" assessment of the task.

I'm Safe

Human Factors & Teams

Illness

Medication

Stress

Alcohol

At the beginning of the day & before a high consequence job, take this test....

Fatigue

Emotions

I'm Safe.

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors

Here is one example of how ORM is used in aviation. We may want to adopt it here.

This is one of the first mnemonics that flight instructors teach their students. It is a simple ORM assessment that each of you can do, too.

Illness....Am I healthy? If not, will the illness impact the reliability and safety of my work?

Medication....Am I taking any? Even over the counter drugs will affect my performance.

Stress....Did anything happen at home...on the way to work...that will affect my performance?

Alcohol....When is the last time I had a drink? (Aviation uses a twelve-hour "bottle-to-throttle" rule of thumb.)

Fatigue....Have I gotten eight hours of sleep? If not, how much will my performance be affected?

Emotion....Are there any that will impact the reliability and safety of my work?

If any of these questions raise "flags," go to your supervisor or team members. Supervisors should encourage technicians to routinely assess their status.

5.4.6 Learning Criteria   Using an example, show what ORM is.

6.   Exercise and Summary 15:00-15:50

Summary of Unit 6 schedule.

Section	Time Allotted (Total time is 50 minutes)
6.1 Teamwork Exercise	35 minutes —1 VG
6.2 Summary	15 minutes —3 VGs, survey

6.1. Risk and Teamwork Exercise

6.1.1.	**Time Schedule and Materials**	15:00—35 minutes
		VG47&48—The survival activity and the map
6.1.2.	**Subject**	Different dynamics can evolve depending on the composition of a team. Different teams will solve problems in different ways.
6.1.3.	**Objectives**	Demonstrate how different team dynamics can evolve.
6.1.4.	**Methods to be Used**	Exercise.
6.1.5.	**Content**	TEAMWORK

As our systems become more sophisticated, the maintenance procedures required to maintain them become more complex. Because of this, the relationships between the people involved in maintaining our systems becomes more critical and important.

Human Factors & Teams

- Survival at a mountain lake

- The attached summary identifies the problem

- You will work individually, then as a team

- After the excercise, we'll look at how the different teams solved the problem.

UC-LLNL, Bennett, 3/14/98, #6   Our Goal Today is to Have Zero Human Errors

SURVIVAL ACTIVITY:

Synopsis

LOST SOUTHWEST OF GOOSE LAKE

Your group has decided to spend two weeks fishing at a friend's isolated cabin near GOOSE Lake, deep in the Sierra Nevadas. Your company has loaned your group the use of the boss's float equipped DHC2 Beaver as a reward for your hard work in keeping the company's systems up and running through the summer. One member of your group, in addition to being an Aviation Maintenance Technician, is

also a seasoned Beaver pilot. Because of the isolation of the cabin, you leave a two-week flight plan with your company.

Pertinent Information

The flight though the mountains begins on a beautiful November day and everything goes without an incident until, north of Alturas, the engine begins to run rough and lose power. The pilot decides to turn back but finds he is unable to maintain altitude due to limited power. He radios your approximate position, but does not receive a reply. Suddenly the engine loses all power and the pilot is forced to land near a rocky shoreline of a small lake. The heavy swells are smashing the aircraft against the rocks. Everyone jumps safely to shore with what they can grab before the aircraft breaks up and sinks in the deep water. It is a beautified late fall afternoon on the coast except the wind is howling and you can see storm clouds on the horizon.

Everyone is dressed in heavy wool clothing, work boots, company caps and comfortable wool jackets.

You decide that you will all stick together no matter what the circumstances and that all decisions will be made by consensus. You have crashed on the shore of a small lake southwest of Goose Lake. The pilot believes there is a closed camp a few miles to the Northeast and the settlement about 20 miles North.

The emergency locator transmitter is with the aircraft and it is doubtful that it activated before the aircraft sank. You do not know if the pilot's call was heard by anyone. There appears to be no readily available source of flesh water.

Weather Synopsis

The weather for this region varies considerably, with the temperature averaging a daily of 47°F and an average low of 38°F. The extremes can vary from 9 to 68°F.

The area averages 14 inches of rain or snow in November and you can expect an average of 24 days of measurable precipitation in the month. The region is often subjected to heavy rain or snow with accompanying winds. The wind is generally from the southeast at an average of 16 m.p.h. with a maximum of 66 m.p.h.

Analysis

Listed in the Appendix are the articles salvaged from the aircraft before it sank. Your task is to individually, without

assistance, list each item in order of importance in Column A with 1 being the most important and 15 the least important.

After everyone has listed them individually, you will work with your group to arrive at a group decision on each item and record your rankings in Column B.

Do not change Column A once you start Column B. Good Luck.

See Appendix A for score sheet, questionnaire, and larger black and white map. The circle on the map shows the approximate location of the crash. How to interpret the scores is presented in the appendix.

**6.1.6 Learning
        Criteria**   Correctly answer questions about factors that can influence team dynamics.

6.2   Workshop Summary

6.2.1	**Time**	15:35—15 minutes

          VG49&50—Review of the goals

          VG51—We are a team
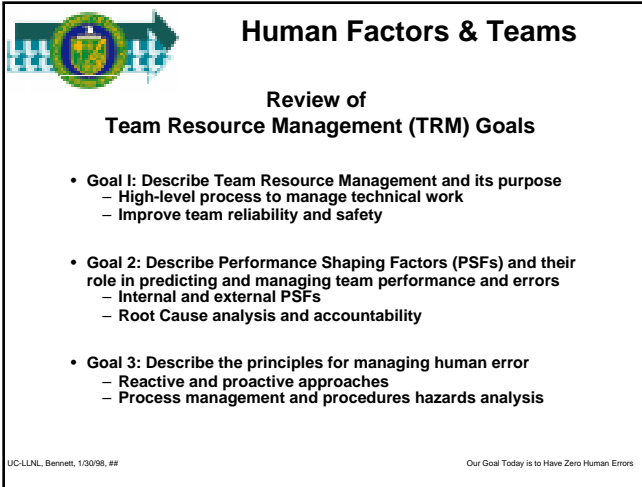
          Survey—Assess post conceptions on TRM, reliability, and safety

6.2.2	**Subject**	Review workshop goals and conduct survey.
6.2.3	**Objectives**	Remind participants of the goals of TRM and what can be done to ensure its use.
6.2.4	**Methods to be Used**	Lecture, discussion, exercise.
6.2.5	**Content**	

Workshop Goals

Human Factors & Teams

**Review of
Team Resource Management (TRM) Goals**

- **Goal I: Describe Team Resource Management and its purpose**
  - **High-level process to manage technical work**
  - **Improve team reliability and safety**

- **Goal 2: Describe Performance Shaping Factors (PSFs) and their role in predicting and managing team performance and errors**
  - **Internal and external PSFs**
  - **Root Cause analysis and accountability**

- **Goal 3: Describe the principles for managing human error**
  - **Reactive and proactive approaches**
  - **Process management and procedures hazards analysis**

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors

Goal 1:	TRM is a process that helps teams manage the conduct of their technical procedure in an orderly, systematic fashion. TRM supports the process management of tasks and operational risk assessment to enhance team reliability and safety. TRM (a) defines the roles and responsibilities of teams, (b) helps develop and maintain a shared concept of the task and its status, and (c) provides tools that act as safety nets to optimize team performance in the face of conditions that might promote human error.
Goal 2:	Individual and team behavior can generally be predicted (specific internal and external factors increase the likelihood that we will act in a certain way). The factors that influence individual and team behavior are called PSFs, which can be

used to predict behavior and, in turn, can be managed to influence behavior. Because PSFs influence behavior, they should be the central focus of a root cause analysis. The person or team that was the immediate cause of an incident should not be solely held accountable. The people responsible for managing the PSFs should also be held accountable.

Goal 3:

Just as human and team behavior can be generally predicted, so too can human error. Reactive methods are necessary because we do not have the time or resources to reliably predict human performance to the degree we would wish. Reactive methods include root cause analysis and lessons learned databases. Proactive methods use risk management tools to understand the failure modes of an operation. Using various psychological principles, methods are systematically developed to optimize human and team performance, and mitigate against errors.

Human Factors & Teams

**Review of Goals of the
Team Resource Management Workshop**

- **Goal 4: Describe TRM's 12 rules-of-thumb (the "Dirty Dozen") and use of safety nets**
  – **Assume trained people will commit errors and act as part of a team to eliminate errors**
  – **Individual (technical) training and team (process) management training go hand in hand**
- **Goal 5: Conduct Operational Risk Management (ORM)**
  – **Rapid, systematic assessment of situation and task**
  – **"Good-enough" management of risk**
- **Goal 6: Demonstrate ways to keep TRM working**
  – **Measure the processes that TRM is supposed to manage**
  – **Monthly process management meetings, principled shift change meetings, and ORM briefs**

UC-LLNL, Bennett, 1/30/98, ##   Our Goal Today is to Have Zero Human Errors

Goal 4:

The "dirty dozen" came from Transport Canada and was developed from actual incidents in aviation. Kennedy Space Center and AVLIS Operations believe that the dirty dozen can be turned into rules-of-thumb (heuristics) that teams can use to optimize their performance. People can be well qualified individually, but fail as part of a team. Team performance is dependent on clearly defined roles and responsibilities and a shared model of the task. We know that task reliability is dependent on more than technically qualified people. Teams, by themselves, do not ensure reliability. Teams must be taught how to manage their processes.

Goal 5: ORM is a tool that the military uses to understand the hazards to the success of a mission. ORM provides a systematic, rapid process for assessing the risk of a mission by evaluating (a) the task (What they are supposed to do?), (b) the conditions (What are the environmental factors?), and (c) the standards (How will they know they have succeeded?). ORM provides principles for understanding at what level a task risk assessment should be done and to what level of detail the analysis should be conducted. ORM can be conducted as part of the shift change meetings or pre-job briefs. ORM is used to further clarify roles and responsibilities for a specific job, as well as ensure the existence of a shared task model among all the team members.

Goal 6: TRM improves team reliability and safety. Set high-level, long-term (6 month) and "in-the-trench," short-term (daily and weekly) goals for your work products and safety. Measure them. "What have I produced for the company? How efficiently have I done it? How safely have I done it? Have I followed rules? Have I made my job better?" Process management focuses on monitoring and improving the job. Shift change meetings focus on the daily work. ORM focuses on safety. In a sense, activities like process management, shift change meetings, and ORM provide the framework for TRM.

We are a Team
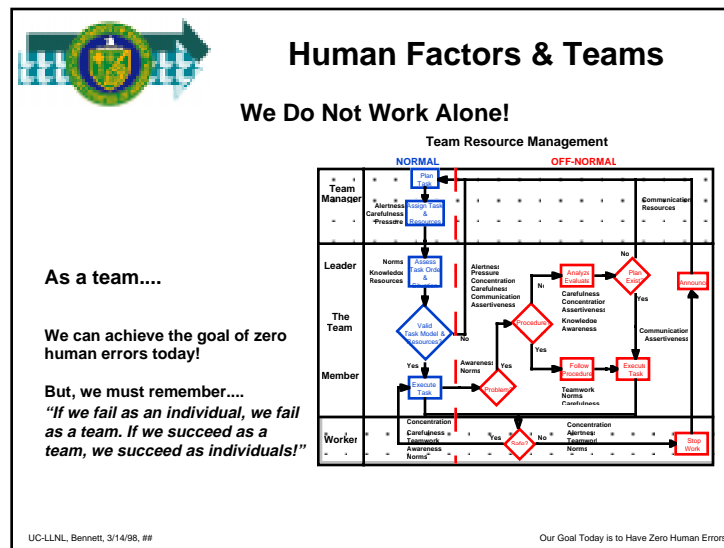
6.2.6 Learning Criteria Correctly answer questions about how to keep TRM working for the organization.